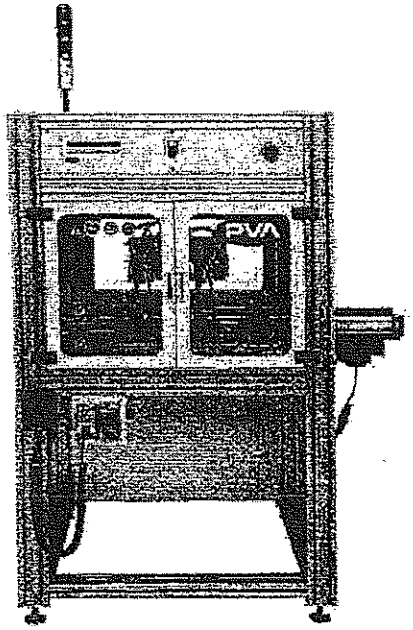
EXHIBIT 68

Coating and Dispensing Installation and Service Manual

Models:

- PVA250
- PVA250E
- PVA350
- PVA550
- PVA650
- PVA750
- PVA2000
- PVA2000C
- PVA3000



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PHONE: (518) 371-2684 - FAX: (518) 371-2684

EXHIBIT 23
Ruben Juarez
03/15/2018
Elizabeth Schmidt
CSR#13598

PVA350™

Automated Dispensing System

P/N: SPCX2115 S/N: W3267

Space X

Operating Guide

15 Solar Drive – Halfmoon, NY 12065

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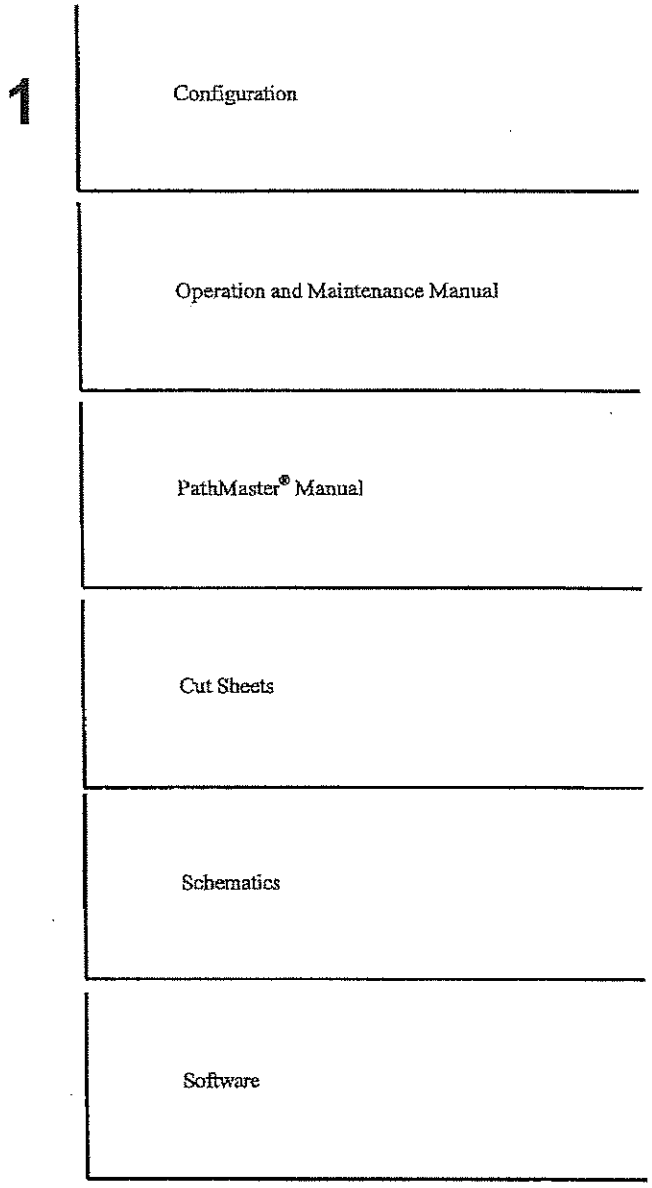
Configuration



Configuration

Notice

Machine Specifics

Serial Number: W3267

Program Revision: 3.04

PathMaster® Version: 2.3.49

Date of Ship: 5/09

Power Requirements

Electrical Rating: 120 Vac, 60 Hz, 12 Amps

Interrupting Capacity: 200 kA

Pressure Settings

Table 1 – Pressure Settings

Regulator	*Description*	*Setting*
REG-1	Main air pressure	90 P.S.I. +/- 10 P.S.I
REG-2	Material air pressure	0-60 P.S.I.
REG-3	Head#1 atom air pressure	0-5 P.S.I.

Valve Nomenclature

Table 2 – Valve Nomenclature

Head #	*Name*	*Description*	*2-slide*	*Rotary*
1	FCS300-ES	Extended Spray Valve	YES	NO
2	FC100-MC	Dispense Valve, Micro adjsut	YES	YES

Optional Equipment

Documentation on non-Standard equipment installed on the workcell is included with this manual. To view these documents click the button below.

Notes

PVA\

Operation and Maintenance

2

- Configuration
- Operation and Maintenance Manual
- PathMaster® Manual
- Cut Sheets
- Schematics
- Software

Operation and Maintenance Manual

Warnings, Cautions, and Notes

Certain warning symbols are affixed to the machine and correspond to notations in this manual. Before operating the workcell, identify these warning labels and read the notices described below. Not all labels may be used on any specific system.

Always wear-approved safety glasses when operating or working near the workcell.

6040

In situations where inattention could cause either personal injury or damage to equipment a warning notice is used.

6014

Do not smoke near the workcell. Always have a fire extinguisher available for emergency use.

6019

Before operating the system, read and understand the manuals provided with the unit.

6017

Before performing any repairs or maintenance to the system, turn off power and lock out the power disconnect switch.

6011

Never place hands or tools in areas designated by this symbol when the machine is in operation. A dangerous condition may exist.

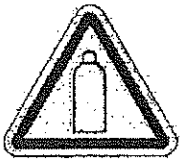
6008

Warning notices are used to emphasize that hazardous voltages, current, temperatures, or other conditions that could case personal injury exist in this equipment or may be associated with its use. Only qualified personnel should enter areas designated with this symbol.

6010

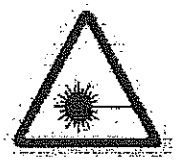
Before performing any repairs or maintenance to the system, read and understand the manuals provided with the unit. A qualified individual should only perform Service.

6018



Exercise caution when pressurized vessels are present. Identify and repair any leaks immediately. Always wear appropriate safety equipment when working with pressurized vessels or vessels containing chemicals.

6054



Laser light source present. Do not stare directly into the beam. Do not use in the presence of highly reflective surfaces.

6003

Pinch hazard from moving parts. Avoid contact.

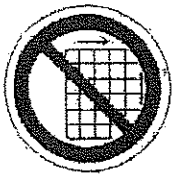
1012

Shear hazard from moving parts. Avoid contact.

1099

Hot surface. Avoid contact.

6043



Do not remove protective guarding.

6060

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained herein does not purport to cover all details or variations in hardware or software, or to provide for every possible contingency in connection with installation, operation, or maintenance. Features may be described herein, which are not present in all hardware and software systems. Precision Valve & Automation, Inc. assumes no obligation of notice to holders of this document with respect to changes subsequently made.

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Preface

Notice & Disclaimer

This manual applies to one of the following automated workcells produced by Precision Valve & Automation, Inc.:

- PVA250™
- PVA250E™
- PVA350™
- PVA550™
- PVA650™
- PVA750™
- PVA1000™
- PVA2000™
- PVA2000C™
- PVA3000™

All machines are referenced throughout the manual as the workcell. This manual provides information and functionality descriptions covering all the common options and configurations for a workcell. The particular machine associated with this manual may not contain all items or may have additions. If the manual refers to an option that was not purchased, ignore that section. If options exist on the machine not mentioned in this manual, please consult the Optional Equipment section of the Operating Guide for more information on these additions.

If the equipment is used in a manner not specified by PVA, the protection provided by the equipment may be impaired.

Contact

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	Website http://www.pva.net/
	Email mailto:info@pva.net
Technical Support	**Tel (518) 371-2684**
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Revisions to This Manual

The following list describes the major revisions in this manual (Rev P 9/07) as compared to the previous version:

- Rewrite for latest program revisions (3.01 & 3.02 & 3.03 & 3.04).
- Altered Power Check procedure and added Door Interlock Check procedure.
- Added compatibility for the PVA250™, PVA2000C™, solvent cups, flow monitor, and teach pendant. 2/10/03 TMB
- Updated Power Check procedure. 2/10/03 TMB
- Added PVA750™ references. 8/1/03 TMB
- Added PVA350™ and PVA650™ references. 3/12/06 PIF
- Added PVA250E™ references. 8/15/06 PIF
- Added warning in notice and disclaimers. 9/17/07 RG
- Changed the open loop (stepper) section to closed loop (servo). 10/09/07 AJH

Content of This Manual

Introduction. Provides an overview of the workcell functionality and physical characteristics.

Installation and Setup. Describes the procedures for installing the workcell and preparing the system for use. Included in this chapter are instructions for unpacking, inspecting, and installing the workcell.

Operating Safety. Basic safety practices are reviewed. The safety devices and guarding for the workcell are described.

Operation. Describes system operations of the workcell. It includes a discussion of the system power-up and power-down sequences and modes of operation.

Troubleshooting. Provides a guide to troubleshooting the workcell. A fault diagnosis table is used to lead the operator through common problems and solutions. Several troubleshooting procedures are described.

Maintenance. Provides a preventive maintenance schedule and replacement procedures.

Appendix A – Definitions. Definitions for commonly used terms.

Appendix B – Serial Communication. A brief overview of establishing communication with the workcell.

Appendix C – Error Codes. A list of error codes that may be encountered while using the workcell.

Appendix D – Closed Loop Speed Settings. A list of maximum speed settings for a closed loop system.

Appendix E – Wiring Schematic Legend. A legend for the numbering and color coding used in the control enclosure for the workcell.

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Introduction

System Description

This manual is intended primarily as a reference for production and operator. However, technical personal that is not familiar with PVA equipment find this manual useful for introduction and training.

The workcell has been designed specifically for applications involving high precision industrial dispensing and spray conformal coating. The flexibility of the machine allows it to be used effectively for a wide range of applications.

The valves are mounted to the end effector of a two, three or four axis Cartesian robot. All dispensing / spraying is performed within the lexan enclosed work area. Limits have been imposed on the axes to prevent damage to the machine. The dispense / spray path and active heads are controlled by a program stored in the motion controller. The controller can store and retrieve up to 30 programs.

NOTE: Not all models are equipped with lexan guarding.

The operator interface (OIT) permits the operator complete control of the machine. This includes machine setup, manual operation, program selection and automatic operation. Machine status and error messages are displayed on the LCD screen and via the optional light tower. It is necessary that operator(s) have read or by training understand the operation of this machine.

Any uses other than listed above could result in a dangerous condition and cannot be protected against by the safety features installed on the system.

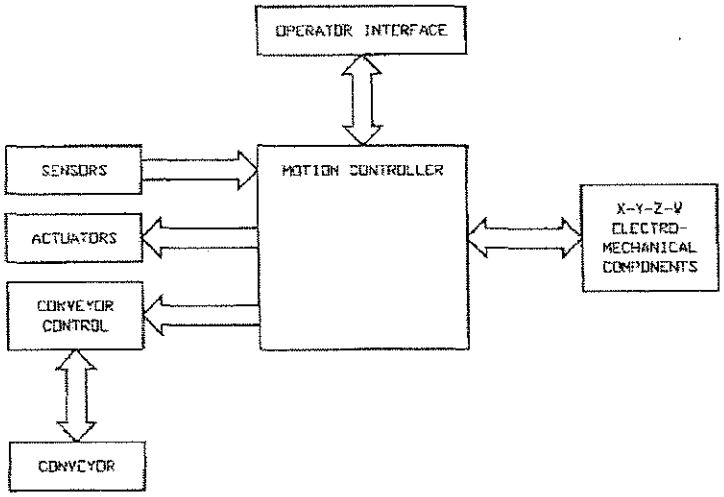


Figure 1 – Workcell Functional Block Diagram

Safety Precautions

Operation of your workcell involves air pressure, electrical power and mechanical devices and the use of Hazardous materials. Is very important that qualify technicians operating and servicing the system fully understand the systems and safety precautions.

Year 2000 Compliance

The workcell is com pliant with and co mprehends the year 2000-century date change. The workcell will not have any operational im pediments, malfunction, cease to perform , generate incorrect or am biguous data and/or produce incorrect or am biguous results with respect to sam e-century and m ulti-century formulas, functions, date values and date-data interfaces.

Intended of Use

Safety is considered a joint responsibility in between the OEM and the e nd –user. All precautions and practices should be in accordance with local regulations.

Using the workcell in other ways than is described in this documentation supplied with the equipment may result in injury or damage of the equipment. Example of this:

- Using incompatibles tools
- Removing doors interlocks or bypassing safety devices
- Making custom mechanics or fluid delivery modifications
- Change material from original design

Emergency Shutdowns

As a minimum push the *EMERGENCY STOP* if someone is in immediate danger, or electric shock

- Unexpected head movement
- If any PCB are in danger or being damage

Emergency Stop Recovery

Do not restart operation until the condition that caused the failure is being alleviated.

- Open the front doors and remove all PCB from the work area
- Close the doors and pull the stop button out
- Press F1 to recover power and restart your program by pressing AUTO

Environmental

Noise Levels

The audible noise level of the workcell is below 65 dBA.

Materials/Chemicals

There are no dangerous materials or chemicals used in the operation of the machine except for the required application material. The application material should include a Material Safety Data Sheet (MSDS), which specifies known dangers and toxicity.

Hazards Due to Contact

The workcell is designed in such a way as to minimize injury from contact with any accessible portion of the machine. However, under certain modes of operation, it is possible to enter the work area while the motion platform is under power. Only a qualified person should do this. All hot surfaces are indicated with a warning label.

Handling, Transportation and Storage

Handling and Transportation

Handling and transportation should be done in such a fashion as to minimize the vibration and shock introduced to the system. An air-ride truck is recommended for roadway transport. Although the machine is designed and built to perform in an industrial environment, excessive abuse will greatly impact the performance of the machine.

Storage

Dust and Debris

All enclosures and connector covers should be closed tightly. It is recommended that a cover be place over the system if dust or other airborne debris is present in the storage area.

Temperature and Humidity

Storage should be done in an area at 40 °F - 105 °F (4 °C – 41 °C) and low humidity. Condensation should not be allowed to collect on the machine.

Dispensing / Spraying Equipment

Whenever the machine is to be stored for extended periods of time, the workcell should be flushed using a solvent compatible with the application material. This includes the following systems, if applicable:

- Dispensing valves spray valves and servo valves.
- Material lines and hoses.
- Pressure vessels.
- Pumping systems.
- Diaphragm pumps

Installation and Setup

WARNING **The following procedures should be performed by qualified persons in accordance with this manual and applicable safety regulations. A "qualified person" is defined as "a person or persons who, by possession of a recognized degree or certificate or professional training, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work." (ref. ANSI/ASME B30.2-1983.)**

Tools and Material needed

The following tools and material will be need for this procedure

- ½ - Inch Wrench
- Forklift
- Work Gloves
- Tie Wrap cutters
- Safety Glasses
- 3 mm hex Key
- 4 mm hex Key
- 5 mm hex key
- Flat Bar

Uncrating and Inspection

1) Use the flat bar and hammer to remove the top and sides of all four sides of the crate
2) Remove all packing materials and strapping.
3) Use the 9/16-inch wrench to remove the following bolts and anchoring the dispensing system to the floor of the crate.
   - Two (2) Bolts in each of the foot (8 Total)
4) Use a forklift to gentle remove the dispense equipment off the pallet; lift the equipment either from the back or the front. Place forks all the way in and making sure that blade reach from front to back.

To place the dispense system

1. Move the dispense system to the location where it will be operated
2. Adjust the forklift height until the dispense equipment is approximately at the required height. If any foot is touches the floor before the forklift reaches the required height.
3. Loosen the locking nuts, if necessary.
4. Once the workcell has reached the approximate required height; make sure that all four levelers (feet) are touching the ground. If any feet are not touching the ground, use the crescent wrench to lower the feet by turning the feet clockwise.
5. Gentle lower the workcell and remove the forklift.

NOTE: It is not necessary to tighten the locking nut at this time.

Inspection

1. Open the front doors, and remove all straps, tie wraps, and sponges around the dispense heads.
2. Thoroughly inspect the exterior of the machine for damage, loose fasteners, etc. Gently move the X & Y axis slide to the center of the work area. At the rear of the machine, inspect all tubing connections, gauges, and regulators.
3. Open the electrical enclosure and visually inspect connectors and components for vibration during shipping. Close the door, as the machine should not operate with the doors open (All accept.
4. Reinstall the Light tower.
5. Reinstall flow monitor. The flow monitor is typically mounted on the rear of the workcell.
6. Reinstall the main air regulator assembly.

NOTE: Step 3 does not apply to PVA250™ and PVA250E ™ models.

Leveling the Workcell

This section describes the procedures for leveling the Workcell. If the workcell is going to use as an in-line system, it needs to be leveled and aligned in relation to upstream and downstream systems. This document does not include procedures for upstream and downstream systems. Alignment procedures should be developed and followed by your facility.

Tools needed

The following tools will be needed to level the workcell

- Level
- Crescent wrench

To level the workcell

1. Place the level in the center of the front conveyor.
2. Observe the position of the bubble within the level window. Determine if the workcell is level from side to side. The bubble should be centered between the two lines.

TIP

If the position of the bubble is positioned to the closer to the right line, the left side of the workcell needs to be raised. If the bubble is outside or positioned closer to the left line, the workcell needs to be raised to the right side.

3. If necessary, loosen the locking nut on each foot using a crescent wrench.
4. Using a crescent wrench, adjust the feet of the workcell by placing the wrench on the flat (unthreaded) part of the pedestal and turning in the desired direction until the workcell is level from side to side.

TIP

Turning the pedestal clockwise raises the workcell. Turning the pedestal counterclockwise lowers the workcell.

5. Check for level at both ends of the conveyors rail by placing the level along the length of the rail
6. Put the level across the center of the conveyors rails, with one end on the front conveyors and the second end in the back rail.
7. Look at the position of the bubble within the level window. Determine if the workcell is level from front to back
8. Check the workcell for all corner stability by putting your hands on top of the workcell in one corner and pressing down. If one of the feet is not touching the ground the workcell will rock back and forth. Adjust the feet so that they are all bearing the weight equally.
9. After checking the corner, re-level the workcell from side to side and front to back if necessary
10. Once the workcell is level from front to back and side to side is stable with all four feet bearing the weight equally, finger tighten the locking nuts by turning them counterclockwise.

Installing the Teach Pendant and Light Tower

1. Locate the light tower on the top rear of the workcell
2. Remove all packaging and material from the light tower including wrapping paper, bubble pack and tape.
3. Locate the existing light tower connection on the top rear of the workcell
4. Align the mast to the extrusion and tighten using a 5mm hex wrench.
5. Connect the two ends of the light tower cables.
6. Locate the Teach Pendant and connect the end into the 15 pin connector located on the front of the workcell.
7. Using a small flat head screwdriver tight the two screws form the Teach Pendant into the threads.

Power Up

Overview

Once you have perform ed the prelim inary installation of the accessories, you are ready to power up the workcell. This section describes the connection of the system to air and power supplies, system power up, and subsequence testing procedures that ensure that all system components are functioning and communicating properly.

WARNING Failure to comply with electrical specifications can result in damage to the machine as well as injury to installation personnel. Electrical hookup must be made by a qualified electrician and must comply with any applicable local standards.

1) Plug the machine into an appropriate power source as determined by the Machine Sp ecific Information section of the Operating Guide or the legend plate on the rear of the machine. The electrical service should be properly grounded, and the power source "clean". If there is high power equipment operating off the same source, a line conditioner may be necessary. Errors in machine operation could indicate poor quality power.

WARNING Make sure that the Main Power switch is off before connecting the workcell to the facility power source.

- All Workcells shipped from: *Precision Valve & Automation* factory is already equipped to handle the voltage being used at the installation site per engineering design.

2) Locate the main air regulator

3) Attach the quick-disconnect air hose to the facility air supply, slowly open the facility air valve

4) Close any access doors and push in the *EMERGENCY STOP* button. At the rear of the machine, turn on the red air lockout valve (PVA250™ and PVA250E™ models are not equipped with an air lockout).

5) A ¼" NPT fem ale fitting is provided at the rear of the m achine (PVA250™ and PVA250E ™ m odels have a ¼" quick disconnect fitting). Connect to a source of clean, dry air. A hose of ¼" inside diameter is sufficient.

6) Ground any pressure vessel to earth or t he m achine. *NOTE: Precision Valve & Automation STRONGLY recommends the machine not be powered on or material added to the pressure vessels until they are properly grounded.*

7) Turn on power at the red handled switch on the front or rear of the machine (PVA250™ and PVA250E™ models have a black "rocker" switch on the rear next to the power cord).

8) Perform Safety check and homing routine, press Manual mode and manually move the head around the entire work area, making sure that it does not encounter any obstacles during travel. Make sure that pneumatic and electrical cables do not impede the heads from travel and are not in danger of being cut or snagged. Please contact *Precision Valve & Automation* if there are any problems.

9) Check the valve brackets and make sure that the valve and brackets are tight and that the valve does not rock or wiggle in the bracket.

10) Close Doors.

Operating Environment

Board Sensor Sensitivity Adjustment procedures

Board sensors are optic sensors located along the length of the front of the conveyors. They are facing upward. They detect the presence of a board or part and send the signal to the motion controller. You should adjust board sensor sensitivity after initial installation and if the sensors are failing the presence of a board.

Depending upon your system configuration, your workcell may have as many as three board sensors, one for each zone (Initial cycle, Spray area, and exit).

Tools needed

- Small flat screw driver
- Production board or sample board that is going to be processed.

To adjust the board sensors

1. Place a board on the conveyors rail and check for the sensor sensitivity, then with the flat head turn it clockwise to set the gain higher or counterclockwise for less insensitivity.
2. Run boards both sides (Top and Bottom).

Location

The machine should be installed on a level surface away from standing water, possible over spray and overhead leaks.

Temperature and Humidity

The machine should be operated in an area at 40°F - 105°F (4°C – 41°C) and low humidity. Condensation should not be allowed to collect on the machine.

Dip Switch Settings

NOTE: During normal operation there is no need to adjust the dip switch settings. If communications between the computer and the controller are not reliable, lower the baud rate on both until communications are satisfactory.

The main RS-232 port on the motion controller must be configured as follows to communicate with the host computer:

Table 1 – DMC-1500 Dip Switch Settings

Switch	*Position*	*Description*
MRST	OFF	Master Reset
1200	OFF	Baud rate selection
9600	OFF	Baud rate selection
19.2K	ON	Baud rate selection
HSHK	ON	Hardware Handshaking

(PVA550™, PVA1000™, PVA2000™, and PVA3000™ models)

Table 2 – DMC-2200 Dip Switch Settings

Switch	*Position*	*Description*
MRST	OFF	Master Reset
XON	OFF	Software Handshaking
HSHK	ON	Hardware Handshaking
9600	OFF	Baud rate selection
19.2K	ON	Baud rate selection
38.4K	OFF	Baud rate selection
OPT	OFF	Hardware Option
ENET	OFF	Use Ethernet port as default for Unsolicited messages.

(PVA250™, PVA250E™, PVA350™, PVA650™, PVA750™, PVA2000C models)

CAUTION **If hardware handshaking is enabled, the program uses the message command and a computer is not attached to the Main RS-232 port, the controller eventually halts. The program included with this machine does not contain any message statements.**

Operator Interface Dip Switch Settings

NOTE: During normal operation there is no need to adjust the dipswitch settings.

The operator interface must be configured to communicate with the controller. The correct settings are given in the table below. These setting enables 9600 baud, 7 data bits, 1 stop bit and 1 start bit.

Table 3 – OIT Jumper Settings

Jumper	*Setting*
E1	A
E2	A
E3	B
E4	B
E5	A
E6	B

Software

The complete workcell software package consists of several items. To avoid problems and miscommunication, it is imperative every operator understand what each piece of software is and its purpose. For more information about PathMaster® and its features, please consult the separate PathMaster® Manual in the Operating Guide.

Main program file

A text file containing the commands that runs the workcell. Under normal circumstances it is not necessary to change this file, but if needed it can be opened and edited with any text editor, such as Microsoft® Notepad or Word. The *Main* program file is downloaded via a drop-down menu in PathMaster® but it should NEVER be opened within the PathMaster® software.

PathMaster®

Precision Valve & Automation's Windows®-based programming software. It is used to create, maintain and download project files for the workcell. The Operating Guide has a separate section on using PathMaster® to program the workcell.

Project File

A text file containing the code for one or more programs. In almost all cases this file is created within PathMaster®. This file is downloaded using PathMaster®.

Machine Communications

For manufacturing lines (multiple machines utilizing conveyor systems) it is necessary for the individual modules to communicate reliably. Therefore, the SMEMA cables must be connected in the correct manner.

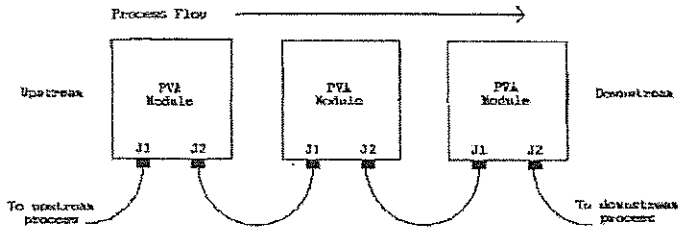
NOTE: On the diagrams the J# refers to the label on the machine, not the label on the cable.

SMEMA

The Surface Mount Equipment Manufacturers Association (SMEMA) Electrical Equipment Interface Standard is used to insure proper sequencing of boards. If these connections are not in place, boards cannot move from one machine to another.

SMEMA cables have male 14-pin amp-type CPC connectors. The cables are straight through, so orientation does not matter. Each machine must have the same transport conveyor height from the floor to the bottom of the PC board. For equipment with an adjustable conveyor width, the front rail is fixed and the rear rail is adjustable. The range of adjustment will vary with the equipment. To sequence the boards properly from machine to machine, one or two signal lines will be used : Board not available and Board Available. On each module, the wire to the J1 (Previous) plug must connect to the J2 (Next) plug on the machine upstream. Similarly, the J2 plug on each machine must connect to the J1 plug on the machine downstream, as shown in the following diagram:

Figure 2 –SMEMA Diagram



Operating Safety

Notices and Warnings

- Safety glasses, gloves, and long sleeved clothing are necessary precautions when working with automated industrial equipment.
- Read and understand all operating manuals before using this equipment.
- Do not disable the safety features of the machine.
- Lock-out and tag the air and power supplies before servicing or cleaning any part of this equipment.
- Do not remove any hose, either air or fluid, without relieving the pressure.
- Do not replace any hose with a hose of inadequate pressure rating.
- Use only replacement parts recommended or supplied by the manufacturer.
- Always remain clear of all moving parts when the system is in operation.

Safety Devices and Guarding

The workcell has several safety features that protect the operator from hazards during normal operation of the machine.

NOTE: The safety features should NEVER be bypassed, disabled or tampered with. Precision Valve & Automation, Inc. is not responsible for any damages incurred, mechanical or human, because of alteration or destruction of any safety features.

Safety Circuit

The main power to the machine is monitored and controlled by the safety circuit. The safety circuit contains two relays, under-voltage protection, and one or more safety devices. The relays are wired in a redundant manner. Redundancy consists of two parallel relay circuits which work together electrically with the safety devices. The tripping contacts of the relays are connected in series to insure that the safety circuit will disconnect power even if one of the relays has failed. Self-checking consists of positive guided contacts which are mechanically forced to operate together. If one of the redundant relays fails, the power contacts are opened. The safety devices monitor the state of the *EMERGENCY STOP* push button and other safety mechanisms. When the safety relay detects that the one or more of the safety devices has opened, the power to the motors and pneumatics is cut.

Lexan Guarding

The work area is enclosed with Lexan guarding. The front of the machine is either open, to allow for manual part loading and unloading, or guarded by doors.

Doors

For machines with an automatic load/unload cycle the front of the machine is protected by two doors. Each door is monitored by a non-defeatable limit switch. When the door is opened power to the motors and pneumatics is dis-

connected. The *DOOR BYPASS* key switch is provided to allow m aintenance personnel access to the work area without disconnecting power. This bypass switch only allows access during Manual and Calibration modes.

Light Curtain

Some machines are equipped with an optional light curtain. The l ight curtain is redundant and self-checking. The control signals from the light curtain are included as safety devices in the safety circuit. On machine power up, the light curtain must be reset by turning the key switch to 'Reset' for at least ½ second.

Exhaust Fan

Some machines are equi pped with an exhaust fan. Th e exhaust fan i s provided to exhaust fumes from the work area. The exhaust flange should be connected to an a ppropriate ducting system that is capable of receiving 150 CFM (cubic feet per minute). Insufficient airflow through the exhaust system generates an error.

NOTE: Installed safety devices vary from model to model.

Operation

Startup Procedure

1) Check the fluid and air pressures.
2) Close all doors and turn the *DOOR BYPASS* key switch to the OFF position (If applicable).
3) Engage the *EMERGENCY STOP* button.
4) Turn on main power using the red rotary switch at the front or rear of the machine (Black "rocker" switch on PVA250™ and PVA250E™ models).

Light Tower Operation

Three stacked indicator lights and a buzzer are used to indicate the status of the machine. The lights are green, amber, and red with green on the bottom, amber in the middle and red on top. The buzzer is located below the green light. The lights are visible from all sides of the machine. The indicators operate as follows. The light tower may help you be your first clue for solving a problem.

- The green indicator is on when the machine is in cycle and producing parts. It is off at all other times.
- The amber indicator is on when the machine is in Auto Cycle and ready to produce parts, but can not cycle due to an external material handling problem (no incoming parts or no room to unload parts). PVA750™ and PVA2000C™ models are equipped with a light tower but not an amber light.
- The red indicator is on steady when the machine is not in Auto Cycle due to operator intervention. It will flash when the machine is in cycle, but cycle is halted due to a machine problem. It is off at all other times.
- The buzzer cycles with the red indicator during machine errors.

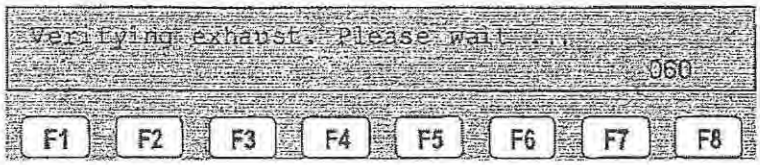
Table 4 – Light Tower & Buzzer Status

State	*Red*	*Amber*	*Green*	*Buzzer*
Cycle Stop	ON	OFF	OFF	OFF
Auto Cycle	OFF	ON	OFF	OFF
In Cycle	OFF	OFF	ON	OFF
Machine Error	FLASH	OFF	OFF	FLASH

Exhaust Verification

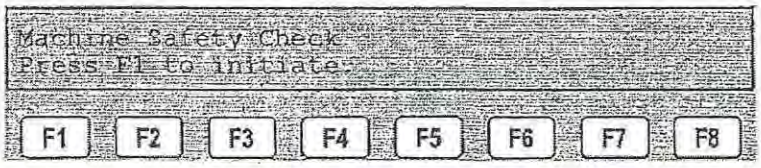
Once the workcell has initialized, most models will perform an exhaust flow verification process. If initialization fails, consult the section Startup Errors on page 44. During this process, and whenever the workcell is in operation the exhaust flow rate is monitored via the on board pressure differential switch. The workcell must exhaust at a rate no less than 150 cubic feet per minute, otherwise a critical fault will occur shutting the motors down. The verification process will also attempt to evacuate any potential vapors that may already exist in the work area of the work-

cell. The time this process takes will vary from model to model, but the remaining time for the process will be displayed as in the screen below:

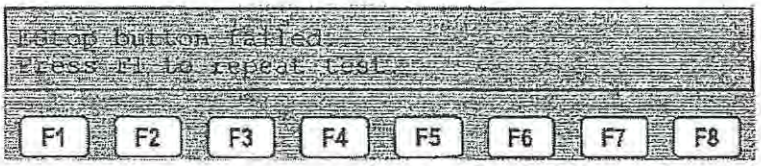


Machine Safety Check

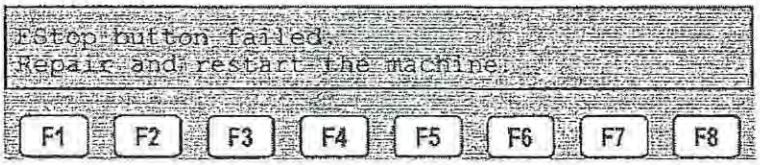
Once initialize and exhaust verification is complete, the operator interface displays the following message:



The machine safety check ensures the workcell safety devices (emergency stop, door interlocks, light curtain, etc.) are operating properly. During startup, the operator must enter the safety check and complete it successfully. Otherwise, the machine halts all operations. After pressing F1 the operator is prompted by the operator interface to activate and deactivate the safety devices and the *POWER ON* button, if present. Certain events in this procedure are timed and if an action is not performed within a specified time the machine interprets this as a failure and displays an error screen such as this:



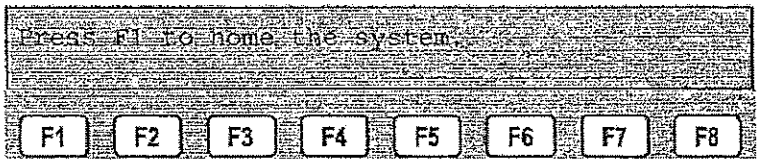
By pressing F1 the operator can repeat the test one time. If a second failure occurs, a screen such as this appears:



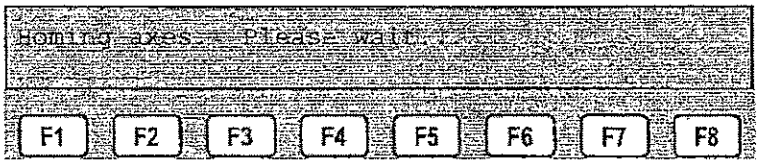
After the second failure the program ceases functioning and the machine must be restarted. The second failure need not be for the same device. An emergency stop failure followed by a door interlock failure halts the program.

If the safety check fails, the entire system should be thoroughly examined by qualified maintenance personnel before the machine is returned to operation.

Homing the Axes



After successfully completing the safety check, the operator is shown the above screen. Pressing F1 homes the system and displays the following screen:



The axes home in the following order: Z, W, then X & Y simultaneously.

Standby Position

Once the machine has completed the homing sequence or finishes a required calibration procedure (if so equipped), it moves to the standby position. Standby is a defined location, DISTIN CT from the home position, although in some circumstances it may be defined as the same position as home. In most cases, the standby position is placed near the board stop to minimize travel during Auto Cycle. The workcell always returns to the standby position in Cycle Stop. If the standby position needs to be changed, please consult the Main Program Modifications section of the PathMaster® Manual.

Solvent Cups

Some workcells has solvent cups installed as an option. The need for solvent cups is dictated by the process by which the workcell will be used for. When solvent cusp are installed, the Auto Purge feature is overridden by the solvent cup routines regardless of the Setup mode settings.

The solvent cup location varies from model to model, however, the location will be somewhere in the workspace of the workcell. Solvent cups are used as a means of maintaining clean dispense / spray heads. In Cycle Stop the heads are situated in the solvent cups. In Manual mode, the heads are removed from the cups and remain out until exiting this mode. In Auto Cycle the heads lift and run the auto purge routine. They return to the solvent cups after a pre-programmed period of inactivity.

To change the time delay before the heads enter the solvent cups in Auto Cycle, change the variable SLP_TM in the Machine-Specific Information section of the *Main* program. A value of 1000 equals 1000 milliseconds or 1 second.

Flow Monitor System

Some workcells have a flow monitor installed as an option. The flow monitor on the workcell measures the amount of material moving through the material supply line **before** it is split to supply the individual valves. It is used as a verification of the dispensing process, not a control of that process, and reports excessive deviations from desired values. The operator determines both the desired material volume and allowable deviation.

Priming the Flow Monitor

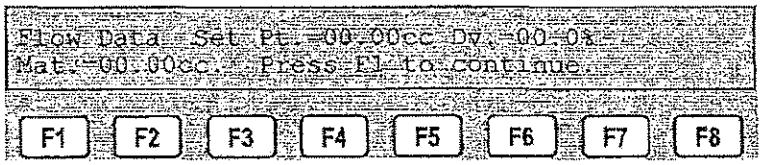
The flow monitor must be primed prior to use to prevent damage to the unit. Priming the flow monitor minimizes the amount of air that will pass through the unit duri ng initial startup. Follow th e procedure below to prim e the flow monitor.

- Fill the pressure vessel with material and seal.
- Set the material pressure regulator to 0 P.S.I.
- Turn the inlet air and outlet material valve to the closed position.
- Disconnect the material line from the inlet port of the flow monitor.
- Turn the air inlet and material outlet valves to the open position.
- Slowly increase the material pressure regulator until material flows from the disconnected material line.
- Turn the outlet material valve to the closed position.
- Bleed pressure for pressure vessel and adjust the material pressure regulator to 0 P.S.I
- Reconnect the material line to the inlet port of the flow monitor.
- Open the valve (dispense or spray) using the manual purge procedure outlined in the operations and maintenance manual.
- Turn the material outlet valve to the open position.
- Slowly increase the material pressure to the target operating pressure.
- Continue the manual purge procedure for each valve until the material flows free of air.

Determining the Correct Material Volume

Before attempting to determine the appropriate material volume, the operator should have a com pleted path program, since any changes to a program alters the flow data results. With the completed program loaded into memory, the operator should enter the Manual mode, position the board correctly with respect to the board stops and run a singular cycle. For m ore information on the Manual mode, please consult page 21 of t he Operation and Maintenance Manual.

After the singular cycle finishes, it displays the following screen:



The 'Mat' value is the amount of material dispensed. The operator should go to the Flow Control mode and change the flow set point to the 'Mat' value that appeared on the flow data screen, then return to the singular cycle option to run more cycles and verify the consistency of the path program.

NOTE: The above screen does not display if the material target level is set to zero in the Flow Control mode. See the section Flow Control Mode for information on changing the material target level.

Setting the Material Volume Check

There are two methods of setting the material volume check parameters.

1) Go to the Flow Control mode and adjust the material volume and deviation parameters.

2) Program the settings into the path program. Two variables are used: AC_SET and AC_DEV. AC_SET is the set point for the material flow, which can range from 0 to 99. AC_DEV is the percent deviation allowed, which can be anywhere from 0 to 99. As an example, entering the following line into a path program: AC_SET=0.500;AC_DEV=5 would put the volume setting at 0.5 cc and the allowable deviation at 5%.

If the settings are programmed into the path program, they are used instead of the settings from Flow Control mode. If no settings are programmed in the path, the machine defaults to the Flow Control mode settings.

Auto Cycle Flow Error

The Auto Cycle checks the material flow after every cycle if the error is turned ON in the Flow Control mode. If the volume was within parameters, no indication is given to the operator. In cases where the volume was outside acceptable parameters, the flow error screen appears. This screen is similar to the flow data screen shown above. The board should be removed before returning the machine to operation.

NOTE: Any changes made to settings in the material delivery system (material pressure, stroke adjustment, etc.) may affect the data from the flow monitor. If this happens, the operator may need to determine the correct material volume again.

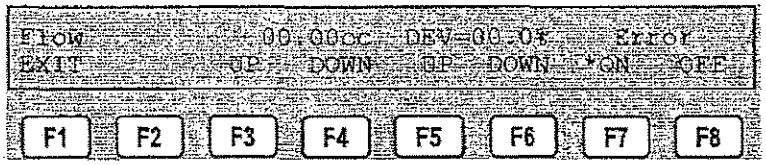
Flow Monitor Calibration

Periodically, the flow monitor calibration should be checked. Start by connecting a PC to the Dispensing System, open a terminal screen and enter DEZ=0. This resets the flow monitor encoder to zero. Then dispense 10 cubic centimeters of material through any valve, by means of a manual purge. When finished, enter MG _DEZ on the terminal screen. This returns a value representing the number of encoder counts read by the flow monitor. Calculate the flow monitor calibration value: (Encoder Counts / 10) = FC_CAL. Change the value of the FC_CAL variable in the Machine-Specific Information section of the *Main* program to the result of the calculation.

NOTE: For a more precise calibration, determine volume by weight. The specific gravity or density of the material must be known to do this.

Flow Control Mode

Flow control mode is typically accessed through the Cycle Stop menu using the F2 function key. If access to Flow Control mode is not achieved through Cycle Stop, or if more than one flow monitor is installed on the workcell, documentation in the Optional Equipment section of the Operator's Guide will provide details on these options.



Flow mode allows control over the flow monitor data that is used as a process check only during Auto Cycle. These settings are used to determine the material volume and whether or not it is excessive unless super exceeded by

commands in a path program. The error selection turns the process verification check on and off. The error ON/OFF selection cannot be overridden by commands in a path program.

[F1] EXIT – Leave Flow mode and return to Cycle Stop.

[F3] cc UP – Increase the material target level. Maximum is 99 cc.

[F4] cc DOWN – Decrease the material target level. Minimum is 0.00 cc.

[F5] DEV UP – Increase the allowable deviation. Maximum is 99%.

[F6] DEV DOWN – Decrease the allowable deviation. Minimum is 0%.

[F7] Error ON – Turn the material flow error checking on. (default)

[F8] Error OFF – Turn the material flow error checking off.

Calibration Procedures

The workcell has one of three calibration methods: Standard, Operator Defined and Sensor Defined. If a Sensor Defined or Operator Defined method is installed on the workcell, the machine may or may not automatically enter its particular calibration mode following the homing sequence depending on the application the workcell was set up for. See page 32 for particulars on operating the workcell during a calibration sequence.

Standard Needle Calibration

The simplest calibration procedure requires the operator to visually inspect the position of a needle with respect to a calibration point (such as cross-hairs). If the needle is not directly above the point, the operator must physically reposition the needle so it is above the calibration point.

Operator Defined Needle Calibration

This method is dependent upon the operator utilizing the trackball to redefine the coordinate system according to the positioning of a specific needle or dispense head. This process is optional. If the specific needle is located in the desired position this process can be skipped.

The calibration routine automatically runs when the machine is powered on or if the controller is reset. The head moves to a calibration point (specified in the main program). When at the calibration position the operator has control of the axes. Using the trackball, the position of the needle tip can be redefined in reference to a calibration point (such as cross-hairs). This process can also be run manually through the CAL function key if a needle needs to be replaced for any reason during operation.

Sensor Defined Needle Calibration

The NCU is referenced from the home position on the gantry. The start positions for each head to enter the NCU are referenced from the cross-hair mark on the top of the NCU. The coordinates are defined for each head using reflective sensors in the NCU. Z is always calibrated first in a downward motion into the Z sensor. The X and Y coordinates are then calibrated from this position in reference to the positioning of the NCU in the work area. The needle moves into the next sensor (X or Y) finding the first coordinate, then moves to the opposite side of the sensor and finds a second coordinate. The calibration routine then calculates the average of the first and second coordinates and redefines the new position accordingly. This sequence is repeated for the remaining axis.

Figure 3 - Needle Sensor Calibration Block

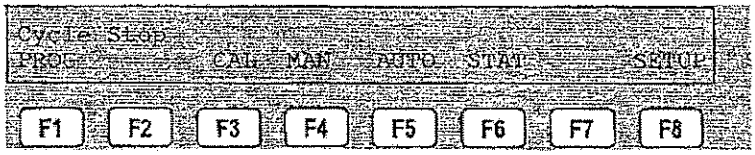
Shutdown Procedure

If the machine is in cycle, wait for the cycle to finish and then return to the Cycle Stop mode. If the machine is in any other mode, the operator should return to Cycle Stop.

1) Press the *EMERGENCY STOP* button.
2) Turn off power to the system. Rotate the main disconnect switch to the "0" position (Rocker switch on PVA250™ and PVA250E™ models).
3) Clean any excess material from the tips of the needles.
4) Remove spray cap(s), wipe tip of needle/seat as well, clean cap thoroughly.
5) If the system will be down for an extended period of time, it is recommended to turn off the air to the machine. The red lockout valve at the rear of the machine can be used for this (not applicable on PVA250™ and PVA250E™ model).

CAUTION **If maintenance is to be performed during the shutdown, be sure to lockout and tag the machine.**

Cycle Stop



The Cycle Stop state is the default state for the workcell. All other modes and capabilities can be accessed from this state through the function key buttons listed below.

[F1] PROG – Change the active program in Program Selection (see page 32).

[F3] CAL – Enter Needle Calibration mode (see page 32).

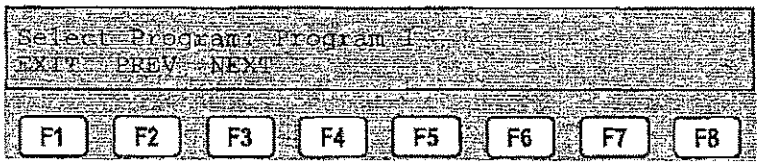
[F4] MAN – Manually operate the machine (see page 34). Also known as Jog or Teach mode.

[F5] AUTO – Run the machine in Auto Cycle (see page 35).

[F6] STAT – Check the status of certain machine items.

[F8] SETUP – View or change the setup functions of the machine (see page 37).

Program Selection



The workcell is capable of storing up to 30 different programs. The program selection menu allows the operator to choose which program is used during the Auto Cycle mode.

[F1] EXIT – Leave program selection and return to Cycle Stop.

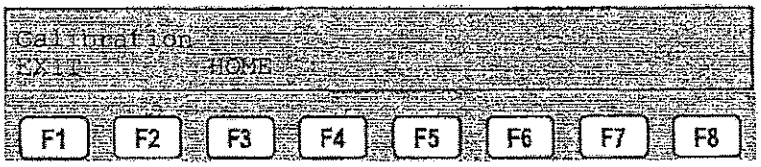
[F2] PREV – Decrement to the previous program.

[F3] NEXT – Increment to the next program.

Needle Calibration

The end effector may contain dispense (as opposed to spray) heads, each of which has a needle. Whenever a needle is replaced or the machine is started the needles should be calibrated. When the machine enters this mode it automatically moves to a pre-set calibration point.

Standard

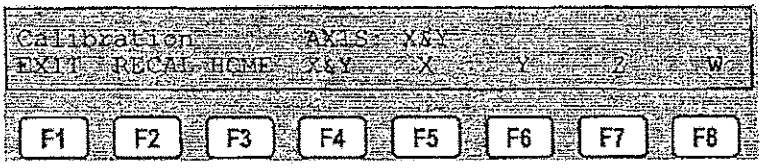


Once at the preset point, the operator must physically reposition the dispense needle to ensure proper calibration.

[F1] EXIT – Leave needle calibration and return to Cycle Stop.

[F3] HOME – Home the system.

Operator Defined



The needle(s) must be positioned over a cross hair. Once the operator is satisfied that the needle is properly positioned, selecting RECAL calibrates the system. The operator can use the trackball to move the end effector.

[F1] EXIT – Leave needle calibration and return to Cycle Stop.

[F2] RECAL – Execute re-calibration.

[F3] HOME – Home the system. The workcell returns to the pre-set point.

[F4] X&Y – Operate the X and Y-axes simultaneously.

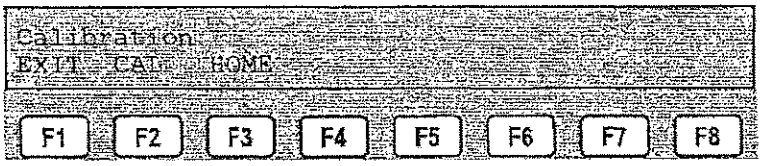
[F5] X – Operate only the X-axis.

[F6] Y – Operate only the Y-axis.

[F7] Z – Operate only the Z-axis.

[F8] W – Operate only the W axis.

Sensor Defined



The sensor-defined calibration is entirely machine run. No operator intervention is required to execute the sequence.

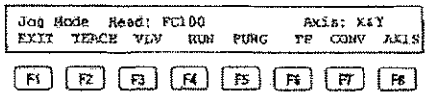
[F1] EXIT - Leave needle calibration and return to Cycle Stop.

[F2] CAL – Run the calibration routine. This is automatic and no operator intervention is required.

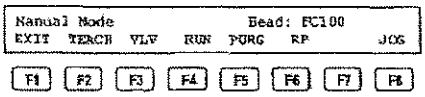
[F3] HOME – Home the system. This automatically runs the calibration routine afterward.

Manual Mode

PVA250E™, PVA350™, PVA550™, PVA650™, PVA1000™, PVA2000™, PVA3000™ models



PVA250™, PVA2000C™ models



Manual mode allows manual control of all devices on the workcell. There are sublevels within Manual mode used to access different workcell functions. The workcell is considered to be in Manual mode even when in a sublevel of Manual mode. Manual mode also serves as the Teach mode for all workcell models. Models equipped with a trackball can jog the gantry via the trackball from Manual mode. An axis combination can be selected from the trackball as well as the Axis sublevel. Models that are not equipped with a trackball (PVA250™, PVA750™, PVA2000C™) can jog the gantry using the function keys from the Jog sublevel menu.

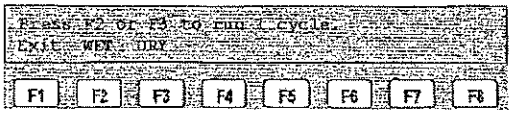
Programming the workcell is accomplished in concert with a PC-compatible computer by using Precision Valve & Automation's PathMaster® software. The operator must be in Manual mode, or a sublevel of Manual mode, for PathMaster® to function properly. For more information on programming, please consult the separate PathMaster® Manual in the Operating Guide.

[F1] EXIT – Leave Manual mode and return to Cycle Stop.

[F2] TEACH – Program the current point.

[F3] VLV – Switch to Valve Selection (see page 35).

[F4] RUN – Run singular cycles of the current program. Pressing F1 exits the mode and returns the operator to Manual mode. In this mode the following screen appears, allowing the operator to run 1 cycle either wet or dry:



[F5] PURG – Actuate the current valve.

[F6] TP – Momentary switch that displays the current position of the head in the following manner:

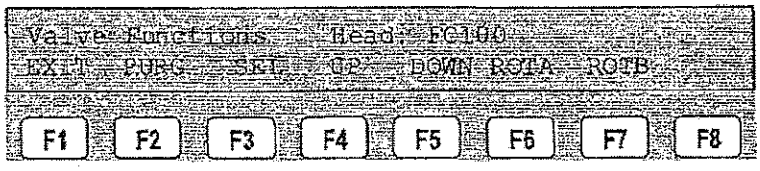
RP – *(PVA250™, PVA750™, PVA2000C™ models only)* Momentary switch that displays the current reference position of the head in the following manner:

[F7] CONV – Switch to Conveyor Control (see page 38).

[F8] AXIS – Switch to Trackball Control (see page 38).

JOG – (PVA250™, PVA750™, PVA2000C™ models only) Switch to Jog Mode (see page 39).

Valve Selection



Units equipped with multiple valves have this mode. The active head or valve can be selected from the Valve sub-level menu. The pneumatics Z-slide(s) and rotary(s) (if equipped) can be actuated from the Valve submenu.

NOTE: When programming or operating the workcell, the valves should NEVER be used for moving components or boards. Precision Valve & Automation is not responsible for damages incurred from using the valves in an inappropriate manner.

[F1] **EXIT** – Leave Valve submenu and return to the previous menu.

[F2] **PURG** – Actuate the current valve.

[F3] **SEL** – Change the active head.

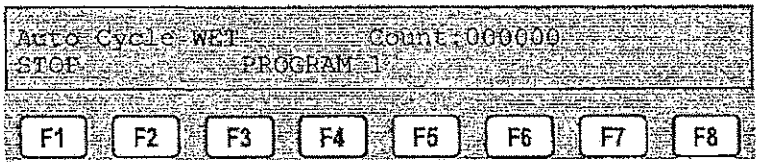
[F4] **UP** – Raise the active head's Z-slide.

[F5] **DOWN** – Lower the active head's Z-slide.

[F6] **ROTA** – Put the rotary in the home position. (Default)

[F7] **ROTB** – Put the rotary in the auxiliary position.

Automatic Mode



This mode handles the automatic cycling of the machine. There are three machine setups that may be encountered:

- Conveyor equipped.
- Stand-alone without a light curtain.
- Stand-alone with a light curtain.

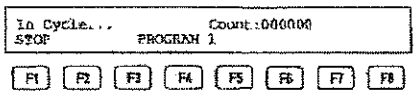
For a workcell with a conveyor, the part is placed for process on the conveyor either by an operator or mechanically via an upstream process. SMEMA signals are provided with the machine to be used in conjunction with an up-stream process. The part is recognized at the entrance to the machine and is shuttled to the stop for cycling. Once against the stop the part is registered and dispensed / sprayed on. Once the program finishes, the board is released

and shuttled to the downstream end of the conveyor to away it any process that may follow. Once released or removed, the process is set to repeat itself.

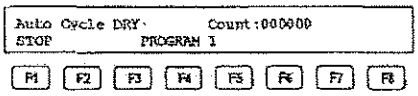
For machines without a conveyor, all parts must be placed in the workcell manually. Part-in-place sensors detect if a board is present or not. If a board is misplaced in the cell, the operator is alerted of the fact. Once a machine is ready for cycling, the operator must activate the hand switches to process parts. All parts must be removed after cycling before a new cycle may begin.

If the workcell possesses a light curtain, it operates in a similar manner as a stand-alone model without a light curtain. However, the light curtain may be used to initiate cycles (bypassing the hand switches).

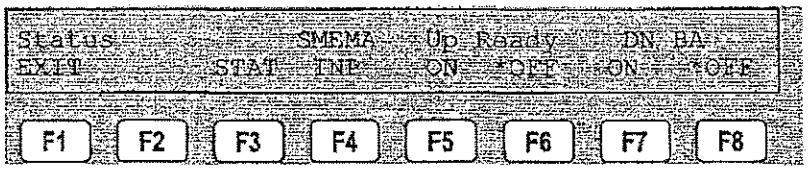
Screen during cycle.



Screen with valves deactivated.



Status Mode

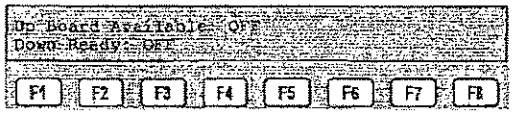


The status mode allows the operator to check a number of machine parameters, running an entire sequence when STAT is selected from within this mode. When the workcell is placed in-line, SMEMA signals ensure communication with the upstream and downstream machines. The operator can check the inputs to the workcell and change the Up Ready and Down Board Available output signals.

[F1] EXIT – Leave Status mode and return to Cycle Stop.

[F3] STAT – Switch to the Status Sequence (see page 36).

[F4] SMEMA INP – Check the status of the SMEMA inputs (momentary). Displays the following screen:



[F5] Up Ready ON – Turn the Up Ready signal on.

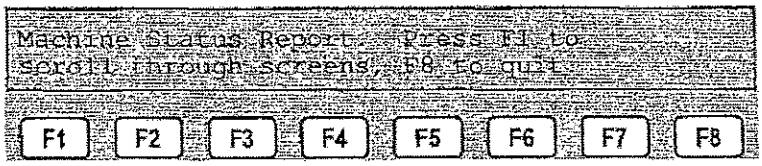
[F6] Up Ready OFF – Turn the Up Ready signal off. (default)

[F7] DN BA ON – Turn the Down Board Available signal on.

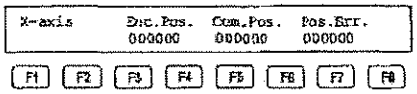
[F8] DN BA OFF – Turn the Down Board Available signal off. (default)

Status Sequence

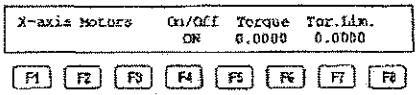
The status features are available via the setup mode and whenever the machine encounters a position error, limit error or command error. It gives information on the status of the axes that may be helpful in debugging a problem. Once the operator enters the status mode, exiting is allowed at any time by pressing F8, while pressing F1 scrolls the operator through the screens.



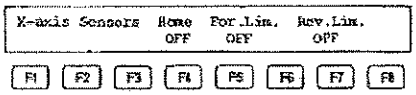
Encoder Status (all except PVA250™)



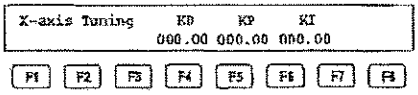
Motor Status



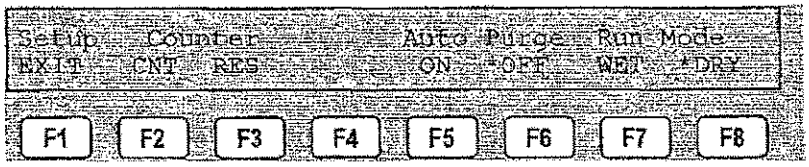
Sensor Status



Tuning Status



Setup Mode



Setup mode allows the operator to control basic functions of the machine. The valves can be turned off during Auto Cycle by setting the run mode to dry. This option does NOT affect the run option in the Manual mode, which is user selected as a wet or dry run.

The auto purge feature dispenses / spra ys material from all valves at specifi c intervals to prevent valves from clogging. The auto purge default setting is dependent upon the type of material used in the workcell. The workcell only auto purges when in Auto Cycle or Cycle Stop. If the workcell is in any other state, it does not auto purge. However, it immediately auto purges, if necessary, once returning to Cycle Stop or Auto Cycle.

NOTE: If the workcell is equipped with solvent cups the auto purge feature is overridden by the solvent cup routines. The system will purge only when needed according to the solvent cup sequence, regardless of the auto purge setting in Setup mode.

[F1] **EXIT** – Leave Setup mode and return to Cycle Stop.

[F2] **Counter CNT** – Display the current cycle count.

[F3] **Counter RES** – Reset the cycle count to zero.

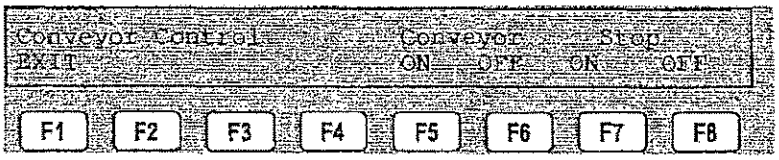
[F5] **Auto Purge ON** – Enable the auto purge feature.

[F6] **Auto Purge OFF** – Disable the auto purge feature.

[F7] **Run Mode WET** – Dispense / spray material during Auto Cycle. (Default)

[F8] **Run Mode DRY** – Material does not dispense / spray during Auto Cycle.

Conveyor Control



The conveyor and stop are controlled in this mode so the operator can position boards in the workcell.

[F1] **EXIT** – Leave Conveyor Control and return to the previous mode.

[F5] **Conveyor ON** – Turn the conveyor on.

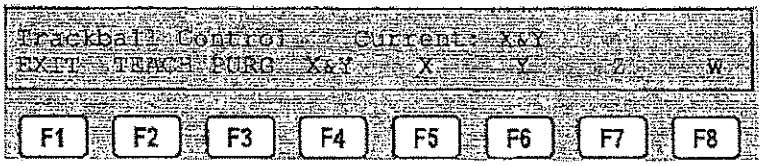
[F6] **Conveyor OFF** – Turn the conveyor off.

[F7] **Stop ON** – Turn the board stop on.

[F8] **Stop OFF** – Turn the board stop off.

Trackball Control

(All models except PVA250™, PVA750™, PVA2000C™)



Trackball Control allows the operator to switch the active axis on the trackball.

[F1] **EXIT** – Leave Trackball Control and return to the previous mode.

[F2] **TEACH** – Program the current point.

[F3] **PURG** – Actuate the current valve.

[F4] **X&Y** – Operate the X and Y-axes simultaneously.

[F5] **X** – Operate only the X-axis.

[F6] **Y** – Operate only the Y-axis.

[F7] **Z** – Operate only the Z-axis.

[F8] **W** – Operate only the W axis.

Teach Pendant

PVA250E™, PVA350™, PVA550™, PVA650™, PVA2000™, and PVA3000™ are equipped with a teach pendant which has a trackball, teach button, purge button, axis selection button, and LED indicators for selected axes and teach function.

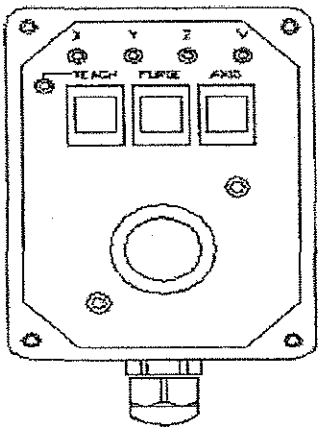


Figure 4 - Teach Pendant

TRACKBALL – The trackball allows the operator to jog each axis independently or X and Y together.

Teach – The teach button mimics the teach button found on the workcell OIT in that it will register the gantry position back to PathMaster® when teaching a motion profile.

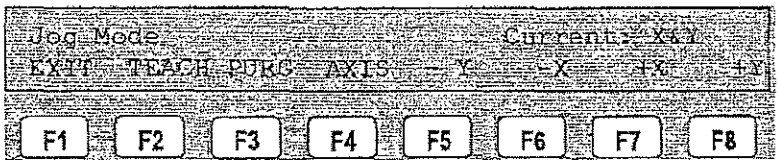
Purge – The purge button mimics the purge button found on the workcell OIT in that it will purge material from the active valve.

Axis – The axis button allows the operator to toggle through the available axis configurations. Typical configurations are X only, Y only, Z only, W only, and X & Y together.

LED's – The X, Y, Z and W LED's represent the selected axis configuration. The teach LED indicates a successful response from PathMaster® when a position is taught. The teach LED is accompanied by a 'beep' from the light tower buzzer.

OIT Jog Control

(PVA250™, PVA750™, PVA2000C™ models only)



OIT Jog Control allows the operator to jog the gantry via the OIT function keys to perform teach functions.

[F1] EXIT – Leave OIT Jog Control and return to the previous mode.

[F2] **TEACH** – Program the current point.

[F3] **PURG** – Actuate the current valve.

[F4] **AXIS** – Toggle axis control between X, Y and Z.

[F5] **-Y** – Jog the Y-axis in the negative direction.

[F6] **-X** – Jog the X-axis in the negative direction.

[F7] **+X**– Jog the X-axis in the positive direction.

[F8] **+Y** – Jog the Y-axis in the positive direction.

To jog an axis, press and hold the function key that corresponds to the axis and direction of motion desired. Once the axis is in motion for approx. 1 sec, the speed will increase by a factor of 15.

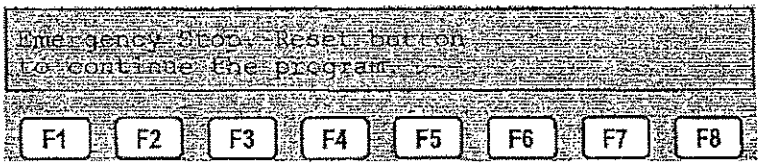
Fault Recovery

Recovering from Emergency Stop and Other Machine Errors

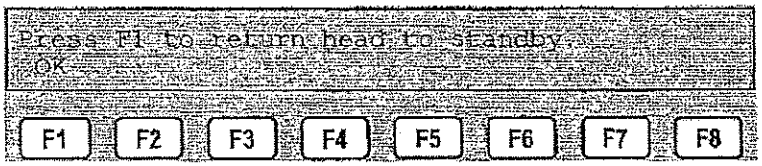
If the operator uses one of the *EMERGENCY STOP* push buttons or the machine encounters a system error, this procedure should be followed to return the machine to the Cycle Stop state.

NOTE: The PVA250™, PVA750™, and PVA2000C models will require the workcell to rehome after recovering from and EMERGENCY STOP, or any other error.

WARNING **If the *EMERGENCY STOP* was activated because of system failure, DO NOT release the *EMERGENCY STOP*. Shutdown the system and have qualified personnel repair the machine.**



1) After reset, press F1 to return the head to the standby position. The screen returns to Cycle Stop.



2) Correct the fault which prompted the operator to emergency stop the machine (open the door, etc).

3) Open the access door.

4) Remove all parts from the work area. Determine which parts can be re-worked and put them in the input queue.

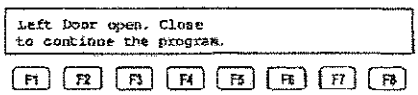
5) Close the access door.

6) Follow the Startup Procedure.

Recovery from a door error, resulting from a door being open while the *DOOR BYPASS* switch is in the OFF position, is handled in a similar manner as an emergency stop. Depending upon the machine setup, other errors could occur, such as low air pressure, low material flow or insufficient exhaust air flow. As with an emergency stop, these errors should be corrected first, then the operator should follow the startup procedure to continue.

Examples of the other possible error screens:

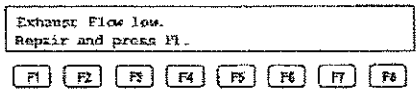
Door Error



Low Air Pressure

Low Material Level

Low Exhaust Flow



Low Air Pressure

There is an air pressure gauge mounted on the main regulator at the rear of the machine, which may include a low-pressure sensor. This is designed as a gross check to verify the main air pressure is being fed to the machine. This prevents damage to moving parts on the end effector. It does not detect slight fluctuations in line pressure but it does detect brief dips below the set point. If such an instance occurs, the machine goes to error for five seconds, then clears the error. The operator must either increase the air pressure or decrease the set point to prevent such an error from happening again.

If any air pressure error is encountered, follow these steps to return the machine to normal operation:

1) Verify that the air pressure is ON.
2) Check that the main air pressure regulator is set for 80-100 P.S.I.
3) If the above settings are correct, and the output light indicator on the air pressure gauge is still lit, verify the set point for the air pressure alarm. Consult the separate are pressure sensor manual for information on setting the air pressure set point.
4) Adjust the set point for approximately 65-75 P.S.I.
5) Restart the machine. If the error persists, the air pressure sensor may be damaged.

Low Material Level

The workcell only checks the material level(s) when running cycles. If there is a material level error, the machine can operate in all its modes (except for cycles) until the material level is reestablished.

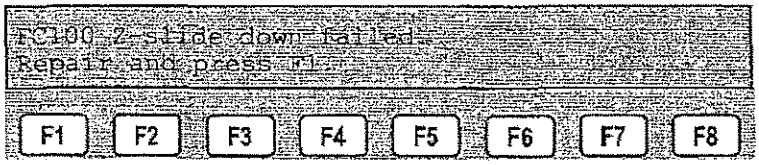
Resetting the Exhaust Fan Overload Relay

Machines with exhaust fans may encounter errors when the overload relays trips. Follow these steps to return the machine to normal operation:

1) Turn machine power OFF.
2) Open the electrical enclosure.
3) Check the tripped flag on the overload relay.
4) Verify that the current set point is set properly on the overload relay. Check the rating on the exhaust fan housing for current draw.
5) If necessary, push the reset button to reset the relay.
6) Restart the machine. If the problem persists, consult the Troubleshooting section on page 46 for more information.

Pneumatic Error Recovery Procedure

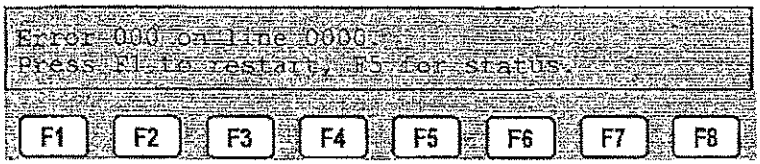
The system pneumatics is checked for errors any time they operate. In addition, any movements to home or the standby position require the pneumatics to be in their "home" position before proceeding. If a pneumatic fails, it generates an error such as the one below.



The operator should determine the cause of the problem before pressing F1 and continuing. Refer to the pneumatic actuator failure section of Troubleshooting (page 46) for more information about diagnosing the problem.

Run-Time Error Recovery Procedure

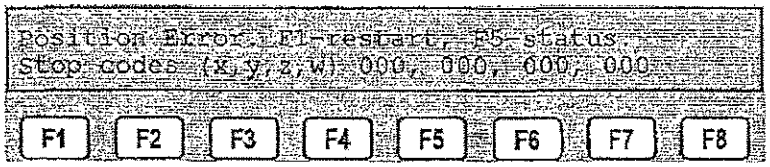
A run-time error is generated during the execution of the program. For more information about programming, please refer to the separate PathMaster® Manual. This type of failure should not be encountered during normal operation of the machine. The most common cause for this type of failure is when using PathMaster® ver. 2.1 or higher and attempting to playback an area function without first downloading a properly formatted project file to the workcell. The operator can check the machine's status screens by selecting F5.



Position Error Recovery Procedure

(All models except PVA250™, PVA750™, PVA2000C™)

A position error is caused when the difference between the commanded position and the current position exceeds the maximum allowable error for an axis. The error limit is defined to be approximately 1/5". For most cases this is 1000 count. The error limit can be reached if the dispense / spray head reaches a hard stop, in Manual mode, if the speed or acceleration is set too high or if the axes drives are not powered. Check the *EMERGENCY STOP* button. The operator can check the machine's status screens by selecting F5.

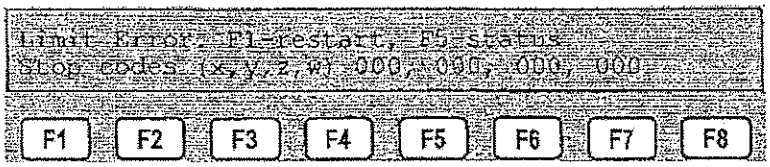


1) Open the access door.
2) Move the dispense / spray head to the center of the work area. The Z-axis is equipped with a brake. The motor coupling can be turned by hand to move the head towards the center of the work area.
3) Close the access door.
4) Press F1 to clear the error.

5) Follow the startup procedure.

Limit Error Recovery Procedure

The machine encounters a limit error in the following cases. First, if the path program attempts to move the dispense / spray head past one of the software limits. If a software limit caused the error, then either the path or the software limits must be changed. The operator can check the machine's status screens by selecting F5.



1) Open the access door.

2) Move the dispense / spray head to the center of the work area. The Z axis is equipped with a brake (all model except PVA250™ and PVA250E™). The motor coupling can be turned by hand to move the head towards the center of the work area.

3) Close the access door.

4) Press F1 to clear the error.

5) Follow the startup procedure.

Stop Codes

(All models except PVA250™, PVA750™, PVA2000C™)

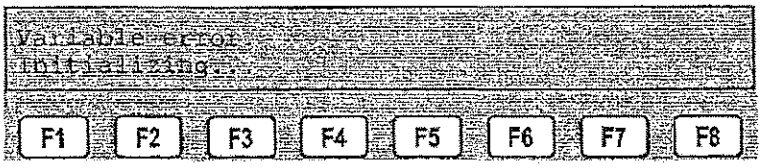
For Position and Limit Errors, the error screen displays the stop codes for all the motors. This information tells the operator which axis (or axes) caused the machine to go to fault.

Table 5 – Stop Code Definitions

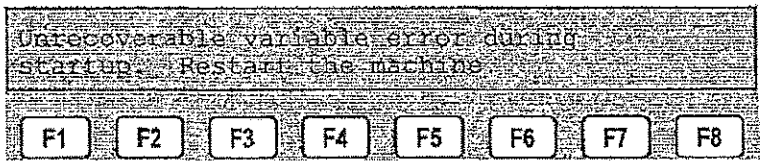
Code	Meaning
0	Motors are running, independent mode.
1	Motors stopped at commanded independent position.
2	Decelerating or stopped by FWD limit switch or software limit, FL.
3	Decelerating or stopped by REV limit switch or software limit, BL.
4	Decelerating or stopped by Stop Command (ST).
6	Stopped by Abort input.
7	Stopped by Abort command (AB).
8	Decelerating or stopped by Off-on-Error (OE1).
9	Stopped after Finding Edge (FE).
10	Stopped after Homing (HM).
50	Contour running.
51	Contour Stop.
99	MC timeout.
100	Motors are running, vector sequence.
101	Motors stopped at commanded vector.

Startup Errors

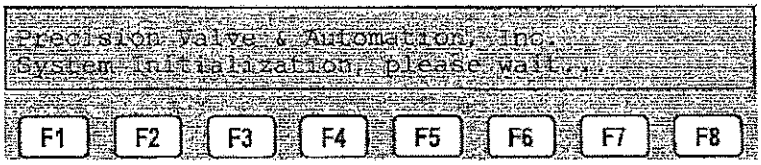
The program saves several variables in the EEPROM through power-down. If the variables are not present or they are out of bounds the following message is displayed. The program automatically initializes the variables and recover from the error.



If the error occurs more than one time during the startup of the machine, the following message is displayed. This indicates a bug in the main program. The original program should be downloaded to the controller.



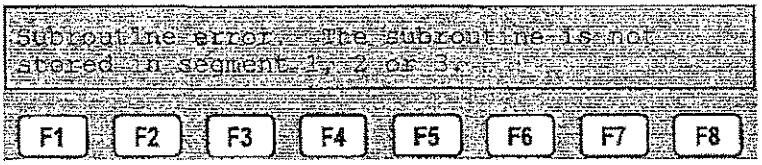
Another potential error occurs when the machine "hangs" on initialization, displaying the following screen (which never changes):



In almost all cases, this occurs when a program's length exceeds the maximum available space in RAM or a defective function key. The solution for this problem is to shorten the active program, or replace the function key membrane panel. Consult the separate PathMaster® Manual in the Operating Guide for more information on altering a program.

Subroutine Error

A Subroutine error occurs if the path programs have not been loaded correctly into segment 1, 2 or 3 of memory. During the Startup Sequence and after Program Selection the main program attempts to load the current program from the segment memory. If the subroutine can not be found the following message is displayed. Please refer to the PathMaster® Manual for more information about downloading.



Troubleshooting

If Something Goes Wrong . . .

Some problems encountered when using the workcell are easy to identify and solve. Others require more extensive help. This troubleshooting section is designed to assist an operator in solving problems before seeking additional help. It is strongly recommended the operator check this section first if a mechanical or electrical problem occurs. If you experience problems that are not listed in this section, or continue after trying different methods, please contact PVA Customer Service. Remember, not every problem can be described in this section, but this should be a good place to start.

***NOTE:** If a problem occurs while running a particular path program, consult the separate PathMaster® Manual for information on debugging code problems.*

Calling Technical Support

The technical support staff is always available to help solve any problems. The phone number is (518) 371-2684. To assist in the troubleshooting process, it is best if as many of the following items are addressed before calling for help:

1) Record all the information on the OIT when the error occurred.

2) Take note of the operation in progress when the machine developed trouble (when did it have problems, what was it doing, etc.).

3) If the error was not serious, attempt to repeat the error. If the error does not repeat, the problem may have been operator generated.

4) Use a terminal screen to communicate with the controller. Most troubleshooting necessitates issuing commands directly to the controller.

5) If the problem is programming related, a hard copy or email of the program in question may be requested by PVA. Please be prepared to send it. The PVA fax number is (518) 371-2688, or the customer service representative will provide an email address, if all parties are email capable.

Records

Any service or replaced components should be recorded in maintenance records and any other pertinent data for future reference.

Fault Diagnostic

The PVA250E™, PVA350™, PVA550™, PVA650™, PVA1000™, PVA2000™, and PVA3000™ models use a closed loop servo drive system were as the PVA250™, PVA750™ and PVA2000C ™ models use an open loop stepper drive system. Listed below are general fault diagnostic table for each type of system.

Closed Loop Servo Systems

Table 6 – PVA250E™, PVA350™, PVA550™, PVA650™, PVA1000™, PVA2000™ and PVA3000™ systems Fault Diagnosis

Operation	Other Symptoms	Possible Cause	Corrective Action
Turn the machine ON. The operator interface does not have power.		Cables are loose or not connected.	• Check the cable connections. Correct any loose connections.
	The electrical enclosure does not have power.	The electrical enclosure is open, so the electrical enclosure safety switch is in the open position.	• Close the electrical enclosure.
		Blown fuse.	• Check FU-1 which is located inside the electrical enclosure. Replace if necessary.
Homing the axes. The end effector moves past the home sensor and hits the hard stop.		Home sensor is out of position or too far away from the homing tab.	• Depress the *EMERGENCY STOP* push button. Move the axis by hand until the homing tab moves into the home sensor. The sensor should be on. Loosen the lock nut on the sensor and readjust to .020" gap.
		Sensor cable is loose or not connected.	• Check the cable connections. Correct any loose connections.
Homing the axes. The Z axis does not move.	End effector can be moved freely when the power is on.	The *EMERGENCY STOP* push button is depressed.	• Release the *EMERGENCY STOP* push button.
	SSR-1 is not ON when the Z axis drive is enabled.	The Z axis brake is not disengaging when the drive is enabled.	• Check the SSR-1 wiring. It should be on when the Z axis drive is enabled.
	SSR-1 is ON when the Z axis drive is enabled.	The fuse for SSR-1 is blown or SSR-1 is damaged.	• Check the fuse using an OHM meter. Replace component if necessary.
Axis does not have any Motion	Encoder works according to the Encoder Feedback Test on page 57.	The axis speed or acceleration has been set to zero.	• Set the speed and acceleration to a positive, non-zero value using the SP and AC commands.

Operation	Other Symptoms	Possible Cause	Corrective Action
	Axis drive light is RED.	Axis drive is not enabled.	• Enable the drive using the SH command.
		The axis cables are loose or not connected.	• Check the cable connections. Correct any loose connections.
		The *EMERGENCY STOP* push button is depressed.	• Release the *EMERGENCY STOP* push button.
		Hall effect sensors are not correctly connected.	• Check the cable connections for the axis. Correct any loose connections. • Check the hall effect sensor phasing using the electrical drawings.
		The axis amplifier is bad.	• Replace the amplifier.
		Doors are open	• Close doors firmly
Axis runs away.		Motor power connections are wired incorrectly.	• Check the phasing using the electrical drawings.
	Z axis encoder does not work.	Z axis encoder/brake cable is loose or not connected.	• Check the cable connections. Correct any loose connections.
		The axis amplifier is bad.	• Replace the amplifier.
Pneumatic actuator failure.	Pneumatics work slowly.	Air lockout valve on the rear of the machine is in the OFF position.	• Turn the lockout valve to the ON position.
		Insufficient air pressure.	• Check and adjust the system pressures to the correct values. Please refer to the Machine Specific Information section of the Operating Guide for particular pressure settings.
		Restricted air line.	• Correct any tight bends or restrictions in the air lines.
		Loose Fitting or Tubing Connection.	• Tighten connection.
		Frayed or damaged air line.	• Replace the damaged air line(s).
		Sensor is not positioned correctly.	• Adjust the sensor location.

Operation	Other Symptoms	Possible Cause	Corrective Action
Part in place sensor failure.		Cable is loose or not connected.	• Check the cable connections. Correct any loose connections.
Conveyor does not run.		Conveyor belt stuck to rails.	• Clean or replace belt.
	No power to conveyor motor.	Control relay not energized or Power On light not illuminated (Certain Models).	• Check voltages and connections.
			• Check conveyor power fuse.
Exhaust fan does not run.	No air flow.	The motor overload relay, OL-1, is in the tripped state.	• Reset the exhaust fan overload relay.
			• Check FU-5 in the electrical enclosure.
		Insufficient air flow capacity in the factory ducting.	• Upgrade the duct to allow for more air flow. • Reset the exhaust fan overload relay.
	The filter and ducting are fine. The motor temperature is normal.	The overload relay current setting has been changed.	• Verify the current setting on the overload relay. Please refer to exhaust fan setup. • Checked the tripped flag on the overload relay. Push the reset button to reset the relay.

Open Loop Stepper Systems

Table 7 – PVA250™, PVA750, and PVA2000C Fault Diagnosis

Operation	Other Symptoms	Possible Cause	Corrective Action
Turn the machine ON. The operator interface does not have power.		Cables are loose or not connected.	• Check the cable connections. Correct any loose connections.
	The electrical enclosure does not have power.	The electrical enclosure is open, so the electrical enclosure safety switch is in the open position.	• Close the electrical enclosure.

Operation	Other Symptoms	Possible Cause	Corrective Action
		The secondary disconnect if off (PVA750™, PVA2000C™ only).	• Check the secondary power disconnect located on the left side of the electrical enclosure in the rear of the machine.
		Blown fuse.	• Check FU-2, FU-3, FU-4 which is located inside the electrical enclosure. Replace if necessary.
Homing the axes. The end effector moves past the home sensor and hits the hard stop.		Home sensor is out of position or too far away from the homing tab.	• Depress the *EMERGENCY STOP* push button. Move the axis by hand until the homing tab moves into the home sensor. The sensor should be on. Loosen the lock nut on the sensor and readjust to .020" gap.
		Sensor cable is loose or not connected.	• Check the cable connections. Correct any loose connections.
Limit Error during homing sequence.	Axes is not moving.	The amp fuse(s) is blown.	• Check F1-F5 fuses located on GPIO interface board.
		Amp cables are loose or disconnected	• Check J9 and J11 connections on GPIO interface board.
		Motor Cable(s) are loose or disconnected	• Verify CPC connections at motor and terminal connections on amp.
X, Y or Z axis does not move.	End effector can be moved freely when the power is on.	The *EMERGENCY STOP* push button is depressed.	• Release the *EMERGENCY STOP* push button.
	LCD Screen indicates that the system is running normally.	The amp fuse(s) is blown.	• Check F1-F5 fuses located on GPIO interface board.
		Amp cables are loose or disconnected	• Check J9, J10 and J11 connections on GPIO interface board.
		Motor Cable(s) are loose or disconnected	• Verify CPC connections at motor and terminal connections on amp.

Operation	Other Symptoms	Possible Cause	Corrective Action
Axis Looses position.		The axis speed or acceleration has been set to too high.	• Check speed, acceleration and deceleration settings. • Refer to Appendix D for speed, acceleration deceleration charts.
		Coupling is slipping.	• Check coupling connection at motor and ball screw. Tighten if needed.
		The axis amplifier is bad. Incorrect AC voltage.	• Replace the amplifier. • Check the power source supplied to the workcell. • Check the power entry module for correct configuration.
Pneumatic actuator failure.	Pneumatics work slowly.	Air lockout valve on the rear of the machine is in the OFF position.	• Turn the lockout valve to the ON position.
		Insufficient air pressure.	• Check and adjust the system pressures to the correct values. Please refer to the Machine Specific Information section of the Operating Guide for particular pressure settings.
		Restricted air line.	• Correct any tight bends or restrictions in the air lines.
		Loose Fitting or Tubing Connection.	• Tighten connection.
		Frayed or damaged air line.	• Replace the damaged air line(s).
		Sensor is not positioned correctly.	• Adjust the sensor location.
Part in place sensor failure.		Cable is loose or not connected.	• Check the cable connections. Correct any loose connections.
Conveyor does not run.		Conveyor belt stuck to rails.	• Clean or replace belt.
		W axis amp fuse(s) is blown.	• Check F4 fuse located on GPIO interface board.

Operation	Other Symptoms	Possible Cause	Corrective Action
		Amp cables are loose or disconnected	• Check J10 and J11 connections on GPIO interface board.
		Motor Cable(s) are loose or disconnected	• Verify CPC connections at motor and terminal connections on amp.
Exhaust fan does not run.	No airflow.	The motor overload relay, OL-1, is in the tripped state.	• Reset the exhaust fan overload relay.
			•
The exhaust fan overload relay trips frequently.	Excessive motor heating. Insufficient air flow.	Blocked exhaust filter leads to excessive motor heating. The overload relay trips.	• Clean the air filter on the exhaust intake. • Reset the exhaust fan overload relay.
		Insufficient air flow capacity in the factory ducting.	• Upgrade the duct to allow for more air flow. • Reset the exhaust fan overload relay.
	The filter and ducting are fine. The motor temperature is normal.	The overload relay current setting has been changed.	• Verify the current setting on the overload relay. Please refer to exhaust fan setup. • Checked the tripped flag on the overload relay. Push the reset button to reset the relay.

Controller Master Reset

Performing a controller master reset returns the Galil controller to factory defaults. All memory, variables and settings stored in the controller are lost. DO NOT perform this operation unless the operator understands how to download the main program and dispense / spray programs. This operation cannot be undone.

1) Turn the machine OFF.
2) Open the electrical enclosure.
3) Locate the DIPswitches on the Galil controller.
4) Move the MRST (master reset) switch to the ON position.
5) Turn the machine ON.

6) Wait for 20 seconds.

7) Turn the machine OFF.

8) Move the MRST (master reset) switch to the OFF position.

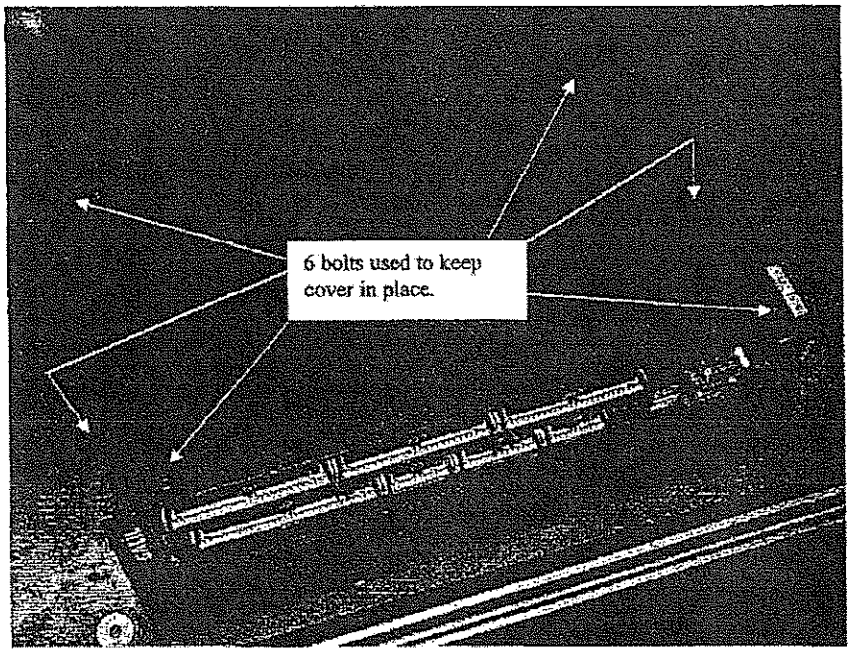
9) Close the electrical enclosure.

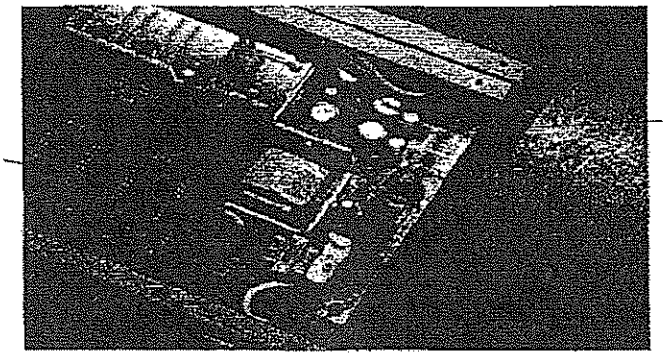
10) Turn the machine ON. There should be no display on the operator terminal.

11) Open a terminal screen and enter the LS (List) command. The controller should return 000 after pressing ENTER. This verifies that the controller is now at factory default and the memory is clear.The controller is ready to accept the main program and a project.

Adjusting or tuning the internal 5V power Supply

Figure 5 - Adjusting 5V power supply





Request Controller Version

Perform the following procedure to request the controller firmware version using the PathMaster® terminal.

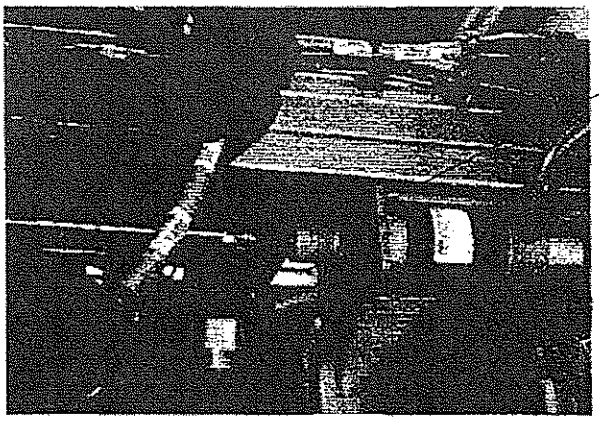
1) Establish communication with the controller. Please refer to the PathMaster® Manual.
2) Open the PathMaster® terminal.
3) Type '^R^V'
4) Press Enter.

The controller version is displayed in the terminal window.

Flexible coupling

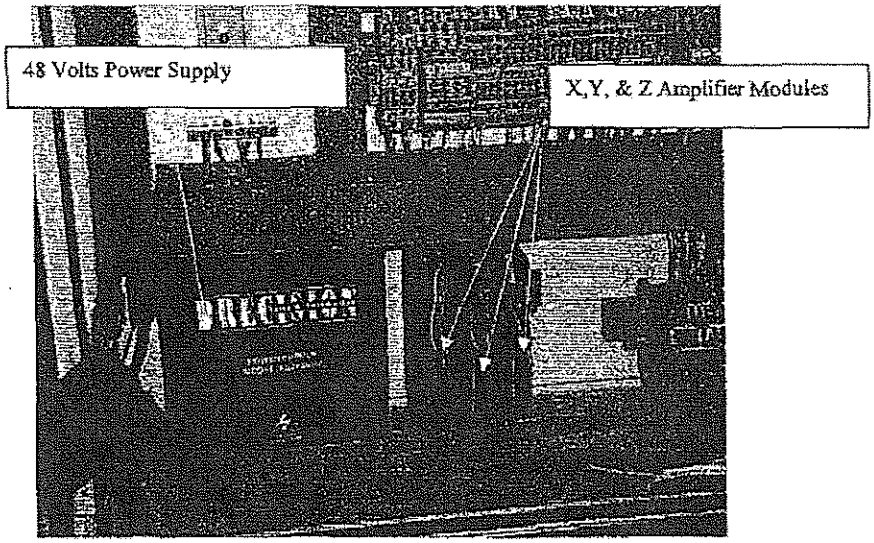
Servo couplings are compensating couplings with a backlash free and conformal torque transfer providing high torsional stiffness and a low moment of inertia. Check periodically if a shifting is suspected.

Figure 6 - Flexible Coupling



Amplifier cards and 48 Volts Power supply

Figure 7 - Amplifier Cards and 48V power supply



All amplifier cards have the same values and it can be interchange for troubleshooting purposes.

EEPROM Upgrade Procedure

(All models except PVA250™, PVA750™, PVA2000C™)

The EEPROM firmware for the controller is periodically updated. If new features are added to the program or machine it may be necessary to upgrade the firmware. DO NOT perform this procedure unless the operator is skilled with replacing chips. Precision Valve & Automation, Inc. is not liable for any damage caused to the controller.

1) Turn the power OFF and open the electrical enclosure.

2) Disconnect all the cables from the Motion Controller and remove the controller from the drawer.

3) Remove the protective metal cover.

4) Avoid any danger of static discharge damage during handling of the controller circuit board and EEPROM chips by wearing a ground strap.

5) Remove the EEPROM chips from the controller and replace with new EEPROMs, making sure to place the L and H labeled chips in the L and H labeled sockets.

6) Perform a Master Reset so that the controller recognizes the new EEPROM firmware. Please refer to the

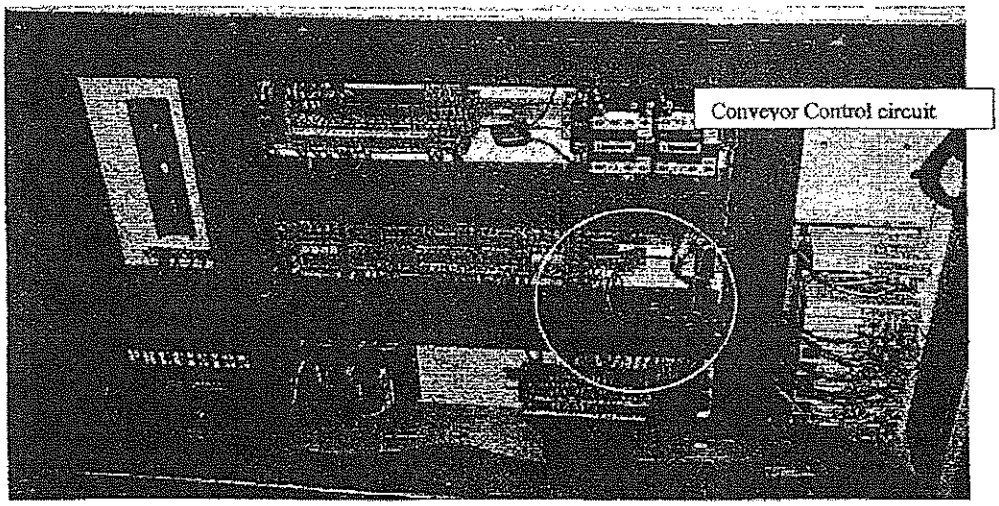
7) Controller Master Reset procedure on page 52.

8) Return the old EEPROMs to Precision Valve & Automation. PVA must have the old EEPROMs back in order to continue service in the future.

Conveyor Speed control

Locate the control cabinet and using a flat screwdriver adjust the speed on the POT R1 clockwise will increase the speed and counterclockwise will slow down the conveyor. *(All models except PVA250™, PVA250E™)*

Figure 8 - Conveyor Control Circuit



Power Check

(All models except PVA250™, PVA250E™, PVA750™, PVA2000C™)

If the expected voltages are not present in the following tests **TURN THE MACHINE OFF IMMEDIATELY.** Permanent damage to the components may occur.

1) Remove all of the fuses in the enclosure, except for FU-1.

2) Disable the enclosure power safety switch.

3) Turn the machine ON.

4) Use a DMM (Digital Multi Meter) to check the AC power in the machine. There should be 110-120 VAC between the 100 and 101 terminals. If not, turn off the power and check that FU-1 is installed and operational.

5) Turn the machine OFF.

6) Install all of the fuses in the enclosure.

7) Push the *EMERGENCY STOP* push button in.

8) Turn the machine ON.

9) CRM-1 and CRM-2 should be DISENGAGED.

10) Check for 5 VDC between 304 (+) and 303 (-).

11) Check for 24 VDC between 306 (+) and 302 (-).

12) Check for 0 VDC between 307 (+) and 302 (-).

13) Pull the *EMERGENCY STOP* push button out.

14) Put a jumper wire between terminal 4 on the 5 V Monitor relay SSR-5 relay and any 304 terminal block (this will engage the SSR-5 relay). If the SSR-5 relay LED is not on, there may be a problem with the SSR-5 relay or the wiring on the coil side.

15) CRM-1 and CRM-2 should be ENGAGED. If not, check the next section (Door Interlock Check) for machines equipped with doors.

16) Check for 24 VDC between 307 (+) and 302 (-).

Door Interlock Check

(All models except PVA250™, PVA250E™, PVA750™, PVA2000C)

1) Engage the Door Bypass switch. If CRM-1 engages when the Door Bypass switch is engaged, there may be a failure in the left door interlock switch, the right door interlock switch, or their wiring.

2) Check for a red indicator light on the 5 V Monitor relay SSR-5. If the indicator is not lit, there may be a failure in the 5 V monitor relay or its wiring.

3) Check for 24 VDC between 504 (+) and 302 (-). If 24 VDC is not present, there may be a failure in the 5 V Monitor relay, the *EMERGENCY STOP* push button PB-1, or their wiring.

4) Check for 24 VDC between 505 (+) and 302 (-). If 24 VDC is not present, there may be a failure in the left door interlock switch or its wiring.

5) Check for 24 VDC between 506 (+) and 302 (-). If 24 VDC is not present, there may be a failure in the right door interlock switch or its wiring.

6) If 24 VDC is present between 506 (+) and 302 (-), there may be a failure in the coil of CRM-1 or a short in its associated diode D-1, or there may be a failure in the coil of CRM-2 or a short in its associated diode D-2.

Encoder Feedback Test

(All models except PVA250™, PVA750™, PVA2000C)

Use this procedure to test the encoder feedback for all of the axes. If a problem is found with any of the encoders repair and report the error to the production supervisor.

Most encoders used with the workcell generate 5080 counts/inch. Check to make sure that the position feedback is reasonable.

(500*4 counts/rev)*(1 rev/cm)*(2.54 cm/in) = 5080 counts/inch.

1) Open a terminal program and establish communication with the DMC-1500 controller.

2) Turn the machine OFF. Disconnect the black motor power cables. Leave the orange encoder feedback cables attached.

3) Move all of the axes to the center of travel position.

4) Turn the machine ON.

5) Enter HX.

6) Define the current position as (0, 0, 0, 0). Enter DP*=0.

7) Move the X-axis in the positive direction and display the current position. Enter TP.

8) Move the X-axis in the negative direction and display the current position.

9) Move the Y-axis in the positive direction and display the current position.

10) Move the Y-axis in the negative direction and display the current position.

11) Move the Z-axis in the positive direction and display the current position.

12) Move the Z-axis in the negative direction and display the current position.

13) Move the W axis in the positive direction and display the current position.

14) Move the W axis in the negative direction and display the current position.

15) Turn the machine OFF.

16) Reconnect the motor power cables.

17) Turn the machine ON.

Motor Feedback Test

(All models except PVA250™, PVA750™, PVA2000C)

Use this procedure to verify that the motor power and hall effect sensors are wired correctly. If a problem is found with any of the axes, repair and report to the production supervisor.

1) Turn the machine ON.

2) Enable the *EMERGENCY STOP* button. This cuts the power to the amplifiers.

3) Open a terminal program and establish communication with the DMC-1500 controller. This can be accomplished via the 'terminal' option in PathMaster®.

4) Enter the following commands via the terminal screen. The motors may be wired incorrectly. The following program limits the acceptable error and power available to the amplifiers. **This protects personnel and equipment.**

```
OE*=1           Off on error enabled for all axes.
ER*=1000        Error limit for all axes.
TL*=1           Torque limit of 1 for all axes.
SP*=5000        Set the speed.
AC*=10000       Set the acceleration.
DP*=0           Define the current position as (0, 0, 0, 0).
SB5             Enable power (only on machines without a POWER ON
                button).
SH              Apply power to the servo motors.
```

5) Release the *EMERGENCY STOP* push button. Push the *POWER ON* button (if present) so it lights up. This restores power to the amplifiers. Care must be taken because any of the axes can move at this time.

6) Command the X-axis to make a positive move. If the axis runs away debug and repeat the procedure.

```
PRX=2000
BGX
```

WARNING **Make sure that the workspace is clear of any obstacles. In the event of a run-away condition, the machine may be irreversibly damaged.**

7) Display the current position and position error. `TP; TE`.

8) Command the X-axis to make a negative move. If the axis runs away debug and repeat the procedure.

```
PRX=-2000
BGX
```

9) Display the current position and position error. `TP; TE`.

10) Repeat step 6 through 9 for the Y, Z and W axes.

Maintenance

Overview

Performing the recommended maintenance procedures and intervals suggested will increase the life and ensure high quality dispensing for every run.

WARNING **Maintenance producers should be completed by qualify and trained personal**

Schedule

Table 8 – Preventive Maintenance Schedule

Type Of Service				
Service Area	*Every Shift*	*Weekly*	*Monthly*	*Quarterly*
Dispensing Equipment	Check all fluid pressures and dispense weights.	Check for material buildup on fixtures and locating surfaces. Check for any leaks around compression fittings. Retighten or replace if needed.	Inspect the fluid delivery lines for excessive wear.	Check the inline material filter for clogging.
Electro-mechanical components		Check motors for overheating and smooth operation. Check for any chaffing of wires, pneumatic lines or material lines. Inspect enclosure air filter, clean with warm soapy water as needed. Air dry before reinstalling. (PVA250™, PVA750™ models only.)	Grease the ball screw slides with Lithium Grease (JIS Type 2).	Inspect all moving cables for excessive wear.
Conveyor System	Clean conveyor belts.	Check for material and dust buildup on the sensors.	Check the conveyor belts for wear.	
Part-in-Place	Clean with warm water, a mild sol-			

Type Of Service				
Service Area	*Every Shift*	*Weekly*	*Monthly*	*Quarterly*
Sensors	vent (like dish soap) and a soft cloth. DO NOT use moderate or harsh solvents, such as Isopropyl Alcohol, Acetone, OS120, etc.			
Pneumatics		Check for proper operation. Drain any accumulated water from the main Filter/Regulator.		Check the slides for wear and smooth operation.
Dispensing / Spraying Equipment		Lubricate packing as per the manufacturers recommendations.		
Clean Purge Cups	Daily			
Clean Valve Tips	Daily			

Procedures

Ball Screw Slides

The slides should be greased via the fitting on the carriage every 100KM or approximately once a month. Clean any buildup on the ballscrew and seals. The manufacturer recommends using a lithium type soap base grease (JIS Type 2). Not all models have slide with grease fitting. If a slide does not have a grease fitting, simply apply a small amount of grease to the slide, then work the slide back and forth.

Inspection

The cables in the flexible cable carrier should be checked for excessive wear. Any worn cables should be replaced. Check for loose screws in the top frame and end effector.

Conveyor Belt Replacement

1) Lockout the power and air supplies.
2) Remove the dust cover plate. The dust cover plate is located near the conveyor motor on the inside of the conveyor.
3) Remove the old conveyor belt from the pulley wheels.
4) Clean the conveyor rails where the belt rides.
5) Install the new conveyor belt. Start by placing the belt on the pulley wheels farthest from the motor. *NOTE: **Make sure that there are no twists in the belt.***
6) Place the belt around the large pulley wheel, then around the remaining wheels.
7) Rotate the pulley wheels several turns by hand. This ensures that the belt is correctly seated.
8) Replace the cover plate.

Valves

Refer to the Cut Sheets section of the Operating Guide for information about the dispensing / spraying equipment.

Servicing the Inline Material Filter

Machines dispensing or spraying low viscosity materials (such as conformal coating) may have an inline stainless steel filter on the pressure vessel. If material flow appears restricted, the filter element could be clogged. All parts of the filter are stainless steel and can be cleaned several times before replacing. Follow these steps to clean or replace the filter:

1) Turn off air supply pressure to the pressure vessel.
2) Turn off the material valve on the vessel.
3) Using two large adjustable wrenches, separate the two sections of the filter.
4) Remove the stainless steel filter element, noting the proper orientation.
5) Clean or replace the filter as necessary.
6) Reassemble the filter and pressurize the system. It may be necessary to purge any trapped air from the system.

Exhaust Fan Setup

1) Turn power OFF.
2) Open the electrical enclosure.
3) Set the overload relay current for 1.0 * FLA for the motor. The FLA is shown on the motor nameplate.
4) Set the reset button to Manual.
5) Restart the machine.

Pressure Differential Switch Setup

NOTE: The flow velocities referred to be only valid for a 5" duct diameter!!!!

1) Turn on the exhaust at 100% speed.
2) Check operation of the pressure switch input. The input should be ON with the exhaust at 100% speed.
3) Turn off the exhaust. Make sure the pressure switch input turns OFF.
4) Restrict the outlet of the exhaust until the airflow velocity is between 1800-2000 ft/min (200-220 cfm) at the exhaust flange screen.
5) Verify that the exhaust pressure switch input is still ON. If it is not, turn the adjustment screw counterclockwise until the input just turns ON.
6) Turn off the exhaust. Make sure the pressure switch turns OFF.
7) Turn on the exhaust. Make sure the pressure switch input turns ON. If not, turn the adjustment screw counterclockwise again until the input turns ON. Verify that the input turns OFF when the exhaust is turned off.
8) Restrict the outlet of the exhaust until the airflow velocity is between 1400-1600 ft/min (155-175 cfm) at the exhaust flange screen.
9) Verify that the pressure switch input stays OFF at this airflow velocity. If the input stays ON, turn the adjustment screw clockwise SLOWLY until the input turns OFF. If an adjustment is made, re-check the input at the airflow velocity used in step 4. The input should still turn ON at an airflow velocity within the range used in step 4.
10) Cycle the exhaust off and back on again. Verify that the pressure switch input stays OFF for an airflow velocity within the range used in step 8.

Part Replacement

Ordering Parts

All customers can order part s by contacting Customer Service Support. Your cust omer servi ce represent ative can help take your order. When ordering spare parts, be prepare to provide the following information:

- Your Company Name
- Billing Address
- Shipping Address
- Serial Number of the Workcell (found on the back of the equipment)
- Part number or description
- Quantity
- Purchase Order or Credit card information
- Shipping Instructions

TIP

Keeping an extra set of frequently used spare parts can help reduce down time.

Return Material Authorization (RMA)

Obtain a Retu rn Material Au thorization (RMA) fro m Pr ecision Valve & Autom ation, Inc. by calling PVA Tech Support.

Training

Because of the replacem ent parts it requires safety a nd familiarity with the equipm ent, Precision Valve & Automation, Inc. offers Training Certificates to Customer technicians, contact PVA.

Warranty

Contact Precision Valve & Automation, Inc. for any warranty issue related with spare parts.

Shipping

When you ordering parts, specify wh ich carrier yo u prefer to use. Precision Valve & Au tomation, Inc. will d eter-mine the best shipping if no instructions are received.

Appendix A – Definitions

Auto Cycle – Machine state where cycles are running.

Auto Purge – A machine function that automatically purges material after a predefined period of time or during solvent cups procedures.

Calibration Position – The location in the workspace where the X, Y, Z and W locations for the needle(s) is normalized.

Cycle Stop – Machine state where no action is occurring and the machine is at the standby position.

Depress – Press and hold for the duration of the operation.

Dispense / Spray Path – A continuous motion profile. The valve is on (dispensing / spraying) during the entire motion profile. Also known as a **Path** or **Motion Sequence**.

DMC – Language used to program the motion controller in the workcell.

End Effector – The dispense / spray head assembly. The end effector is moved by the axes.

Function Keys – A set of eight membrain buttons located on the OIT used to select various modes and functions of the workcell.

Head – Dispensing / spraying valve.

Home Position – The (0, 0, 0, 0) location of the workspace. This position is determined by the location of the home sensors. It is NOT the same as the **Standby Position**.

Jog – Moving any combination of axes continuously at a set rate of speed until commanded to stop.

Light Tower – The light tower consists of three stacked lights, red, amber and green (top to bottom). It is used to indicate the status of the machine.

***Main* program file** – Text file containing the code that runs the workcell during normal operations.

Motion Sequence – A continuous motion profile. The valve is on (dispensing) during the entire motion profile. Also known as a **Dispense / Spray Path** or **Path**.

OIT – Operator Interface terminal.

Path – A continuous motion profile. The valve is on (dispensing / spraying) during the entire motion profile. Also known as a **Dispense / Spray Path** or **Motion Sequence**.

PathMaster® – Windows® programming software. Used to create, maintain and download program files for the workcell.

Press – Press and release.

Program – A collection (or series) of motion sequences.

Project – File containing the code for one or more programs (typically 30 programs).

Purge Position – The location in the workspace where the head moves to perform all auto purge operations.

PVA – Precision Valve & Automation, Inc.

Solvent Cups – Reservoirs containing a compatible solvent used to maintain the dispense / spray valves when the workcell is not processing product.

Solvent Position - The location in the workspace where the head moves to rest in a solvent solution to maintain the dispense / spray valves when the workcell is not processing product.

Standby Position – The rest position for the end effector. The machine moves here after homing and after each cycle. This position is usually located near the start point for the program(s). It is NOT the same as the **Home Position.**

Terminal – A program used as a communication link between the controller and operator.

Teach – A process by which the workcell registers its current gantry location with PathMaster® to create a motion sequence.

Workcell – A model PVA250™, PVA250E™, PVA350™, PVA550™, PVA650™, PVA750™, PVA1000™, PVA2000™, PVA2000C™ or PVA3000™ automated system.

Appendix B – Serial Communication

Serial Communication

Overview

The workcell communicates with a computer using the EIA RS-232C standard. The computer is the Data Terminal Equipment (DTE Device) and the controller is the Data Communications Equipment (DCE Device). The tables below give a brief overview of the connections required to communicate between DTE and DCE devices.

WARNING **The computer must be at the same ground potential as the machine. Damage to the machine or computer may result if the ground potentials are different. Use the workcell service outlet for computer power if provided.**

9 Pin Serial Connector

Table 9 describes the pinout for standard serial ports found on most portable computers.

Table 9 – DTE 9 Pin Serial Connector

Pin	*Description*
1	Carrier Detect (CD)
2	Received Data (RD)
3	Transmitted Data (TD)
4	Data Terminal Ready (DTR)
5	Signal Ground
6	Data Set Ready (DSR)
7	Request to Send (RTS)
8	Clear to Send (CTS)
9	Ring Indicator (RI)

25 Pin Serial Connector

Table 10 describes the pinout for standard serial ports found on most desktop computers.

Table 10 – DTE 25 Pin Serial Connector

Pin	*Description*
1	Protective Ground
2	Transmitted Data (TD)
3	Received Data (RD)
4	Request to Send (RTS)
5	Clear to Send (CTS)
6	Data Set Ready (DSR)
7	Signal Ground
8	Carrier Detect (CD)
9	+Voltage
10	-Voltage
11	Unused
12	Secondary CD

13	Secondary CTS
14	Secondary TD
15	DCE Transmitter Clock
16	Secondary RD
17	Receiver Signal Clock
18	Unused
19	Secondary RTS
20	Data Terminal Ready (DTR)
21	Signal Quality Detector
22	Ring Indicator (RI)
23	Data Signal Rate Selector
24	DTE Transmitter Clock
25	Unused

Computer 9 Pin to workcell Programming Port

For standard communication between a computer and a workcell.

Table 11 – Cable for Computer DB9 to workcell

Comp DTE DB9	workcell *DCE DM9F*
1	1
2	2
3	3
4	4
5	5

Computer 25 Pin to workcell Programming Port

For standard communication between a computer and a workcell.

Table 12 – Cable for Computer DB25 to workcell

Comp DTE DB9	workcell *DCE DM9F*
1	5
2	3
3	2
4	1
5	4

Appendix C – Error Codes

DMC Error Codes

Table 13 – DMC Error Codes

ID	*Description*
1	Unrecognized command
2	Command only valid from program
3	Command not valid in program
4	Operand error
5	Input buffer full
6	Number out of range
7	Command not valid while running
8	Command not valid while not running
9	Variable error
10	Empty program line or undefined label
11	Invalid label or line number
12	Subroutine more than 8 deep
13	JG only valid when running in jog mode
14	EEPROM check sum error
15	EEPROM checkwrite error
16	IP incorrect sign during position move or IP given during forced deceleration
17	ED, BN and DL not valid while program running
18	Command not valid when contouring
19	Application strand already executing
20	Begin not valid with motor off
21	Begin not valid while running
22	Begin not possible due to Limit Switch
24	Begin not valid because no sequence defined
25	Variable not given in IN command
28	S operand not valid
29	Not valid during coordinated move
30	Sequence segment too short
31	Total move distance in a sequence > 2 billion
32	More than 511 segments in a sequence
41	Contouring record range error
42	Contour data being sent too slowly
46	Gear axis both master and follower
47	Gearing and coordinated moves cannot run simultaneously
50	Not enough fields
51	Question mark not valid
52	Missing " or string too long
53	Error in {}
54	Question mark part of string
55	Missing [or []
56	Array index invalid or out of range
57	Bad function or array

ID	*Description*
58	Unrecognized command in a command response (i.e._GNX)
59	Mismatched parentheses
60	Download error - line too long or too many lines
61	Duplicate or bad label
62	Too many labels
65	IN command must have a comma
66	Array space full
67	Too many arrays or variables
71	IN only valid in task #0
80	Record mode already running
81	No array or source specified
82	Undefined array
83	Not a valid number
84	Too many elements
90	Only X Y Z W valid operand
95	TM too large for stepper pulse
96	SM jumper needs to be installed for stepper motor operation
100	Not valid when running ECAM
101	Improper index into ET (must be 0-256)
102	No master axis defined for ECAM
103	Master axis modulus greater than 256*EP value
104	Not valid when axis performing ECAM
105	EB1 command must be given first
118	Controller has GL1600 not GL1800

Appendix D – Closed Loop Speed Settings

Maximum Speed settings

The "closed loop" design of the PVA servo driven systems will generate a position error if the speed, acceleration or deceleration parameters are set to high. If the system is commanded to move at a speed that the motors are not capable of achieving, the motion controller does not know the capabilities of the motor and will therefore expect the motors to keep pace. Since the motors cannot keep pace, the difference between the commanded position from the motion controller and the actual motor position from the encoder will increase to a predetermined maximum (typically 1000 counts), and then the controller will generate a position error.

PVA550 / PVA650				
Axis	*Max Speed*	*Max Scaled Speed (10x)*	*Max Accel / Decel*	*Max Accel / Decel Scaled (10x)*
X-Axis	125000 cnts/sec	N/A	700000 cnts/sec^2	700000 cnts/sec^2
Y-Axis	125000 cnts/sec	N/A	700000 cnts/sec^2	700000 cnts/sec^2
Z-Axis	125000 cnts/sec	12500 cnts/sec	700000 cnts/sec^2	70000 cnts/sec^2

PVA2000 / PVA3000				
Axis	*Max Speed*	*Max Scaled Speed (10x)*	*Max Accel / Decel*	*Max Accel / Decel Scaled (10x)*
X-Axis	125000 cnts/sec	N/A	700000 cnts/sec^2	N/A
Y-Axis	125000 cnts/sec	N/A	700000 cnts/sec^2	N/A
Z-Axis	125000 cnts/sec	N/A	700000 cnts/sec^2	N/A
W-Axis	80000 cnts/sec	N/A	500000 cnts/sec^2	N/A

Conversion
5080 cnts = 1 inch
200 cnts = 1 millimeter

Note:

The Parameters listed above are general guidelines. The load on each axis will have a large impact on these parameters. The load on each axis can vary greatly depending on machine configuration. The parameters listed above may not be optimal for all processes. Typically the dispense or spray speed (vector Speed for coordinated motion) is much slower than the move speed (independent motion).

Appendix E – Wiring Schematic Legend

Wire Numbering

Table 14 – Wire Numbering

Type	*ID*	*Example*	*Description*
DC Control	400 - 599	400	
DC Supply	300 - 399	300	
AC Control	200 - 299	200	
AC Control Power	100 - 199	100	
AC Supply Power	nLm	1L2	Segment 1 of AC Supply Phase 2
Ground	GND	GND	
Neutral	NEU	NEU	
AC or DC Motor	nTm	1T2	Motor 1, phase 2
Inputs	n1mm	1101	Module 1, Input 01
Outputs	n0mm	2001	Module 2, Output 02
Connector	Jnnn/mm	J100/5	Connector 100, pin 5

Wire Color Code

Table 15 – Wire Color Code

NOTE: This color code does not apply to multi-conductor cables.

Type	*Color*	*Example*
DC (<150 V)	BLUE	0 Vdc, 80 Vdc
DC (>150 V)	BLACK	200 Vdc
AC (<150 V)	RED	120 Vac
AC (>150 V)	BLACK	208 Vac, 480 Vac
Neutral	WHITE	
Ground	GREEN or GREEN with YELLOW	
Remote	YELLOW	Remote control circuit

Appendix E – Wiring Schematic Legend

Wire Numbering

Table 16 – Wire Numbering

Type	*ID*	*Example*	*Description*
DC Control	400 - 599	400	
DC Supply	300 - 399	300	
AC Control	200 - 299	200	
AC Control Power	100 - 199	100	
AC Supply Power	nLm	1L2	Segment 1 of AC Supply Phase 2
Ground	GND	GND	
Neutral	NEU	NEU	
AC or DC Motor	nTm	1T2	Motor 1, phase 2
Inputs	n1mm	1101	Module 1, Input 01
Outputs	n0mm	2001	Module 2, Output 02
Connector	Jnnn/mm	J100/5	Connector 100, pin 5

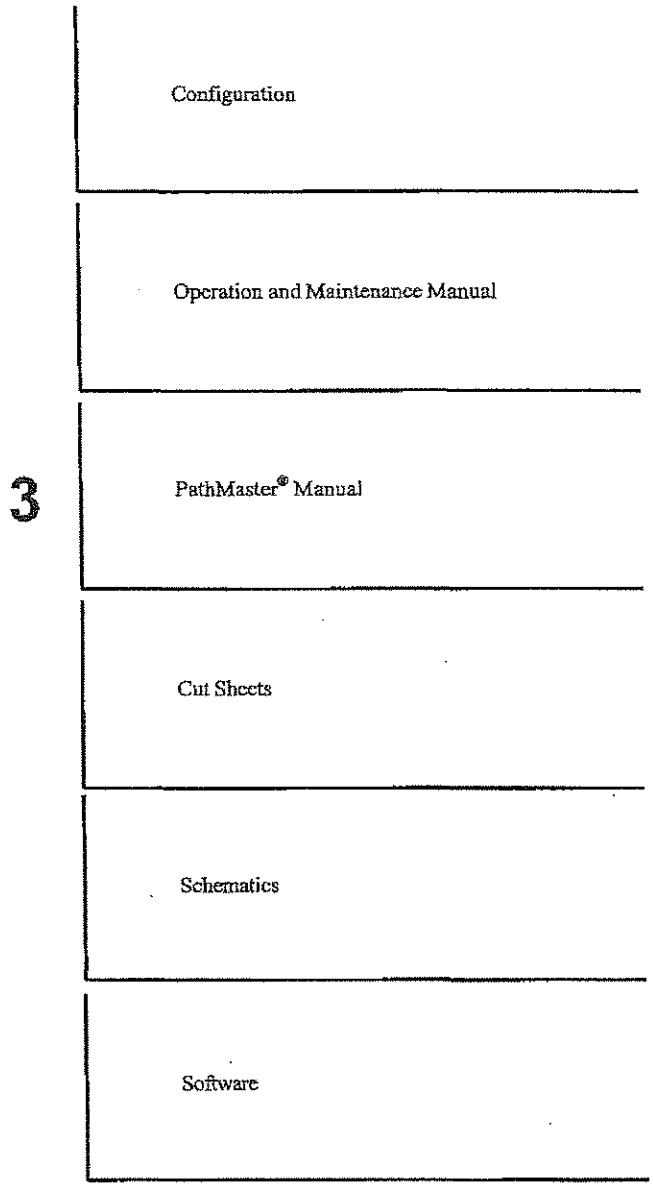
Wire Color Code

Table 17 – Wire Color Code

*NOTE: **This color code does not apply to multi-conductor cables.***

Type	*Color*	*Example*
DC (<150 V)	BLUE	0 Vdc, 80 Vdc
DC (>150 V)	BLACK	200 Vdc
AC (<150 V)	RED	120 Vac
AC (>150 V)	BLACK	208 Vac, 480 Vac
Neutral	WHITE	
Ground	GREEN or GREEN with YELLOW	
Remote	YELLOW	Remote control circuit

PathMaster®


3
Configuration
Operation and Maintenance Manual
PathMaster® Manual
Cut Sheets
Schematics
Software

PathMaster® Manual

Warnings, Cautions, and Notes

Certain warning symbols are affixed to the machine and correspond to notations in this manual. Before operating the Dispensing System, identify these warning labels and read the notices described below. Not all labels may be used on any specific system.

Always wear approved safety glasses when operating or working near the Dispensing System.

6040

In situations where inattention could cause either personal injury or damage to equipment a warning notice is used.

6014

Do not smoke near the Dispensing System. Always have a fire extinguisher available for emergency use.

6019

Before operating the system, read and understand the manuals provided with the unit.

6017

Before performing any repairs or maintenance to the system, turn off power and lock out the power disconnect switch.

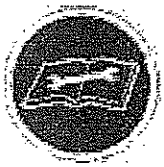
6013

Never place hands or tools in areas designated by this symbol when the machine is in operation. A dangerous condition may exist.

6008

Warning notices are used to emphasize that hazardous voltages, current, temperatures, or other conditions that could case personal injury exist in this equipment or may be associated with its use. Only qualified personnel should enter areas designated with this symbol.

6010

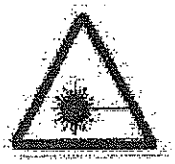


Before performing any repairs or maintenance to the system, read and understand the manuals provided with the unit. Service should only be performed by a qualified individual.

6018

Exercise caution when pressurized vessels are present. Identify and repair any leaks immediately. Always wear appropriate safety equipment when working with pressurized vessels or vessels containing chemicals.

6054



Laser light source present. Do not stare directly into the beam. Do not use in the presence of highly reflective surfaces.

6003

Pinch hazard from moving parts. Avoid contact.

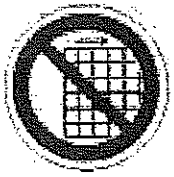
1012

Shear hazard from moving parts. Avoid contact.

1099

Hot surface. Avoid contact.

6043



Do not remove protective guarding.

6050

This document is based on information available at the time of its publication. While efforts have been made to be accurate, the information contained herein does not purport to cover all details or variations in hardware or software, nor to provide for every possible contingency in connection with installation, operation, or maintenance. Features may be described herein which are not present in all hardware and software systems. Precision Valve & Automation, Inc. assumes no obligation of notice to holders of this document with respect to changes subsequently made.

Precision Valve & Automation, Inc. makes no representation or warranty, expressed, implied, or statutory with respect to, and assumes no responsibility for the accuracy, completeness, sufficiency, or usefulness of the information contained herein. No warranties of merchantability or fitness for purpose shall apply.

Preface

Notice & Disclaimer

This manual applies to one of the following automated workcells produced by Precision Valve & Automation, Inc.:

- PVA250™
- PVA550™
- PVA750™
- PVA1000™
- PVA2000™
- PVA200C™
- PVA3000™

All machines are referenced throughout the manual as the Dispensing System or Workcell. This manual provides information and functionality descriptions covering all the common options and configurations for a Dispensing System. The particular machine associated with this manual may not contain all items or may have additions. If the manual refers to an option that was not purchased, ignore that section. If options exist on the machine not mentioned in this manual, please consult the Optional Equipment section of the Operating Guide for more information on these additions.

Revisions to This Manual

The following list describes the major revisions in this manual (Rev. H 6/03) as compared to previous manuals:

- Rewrite for PathMaster® version 2.05, including subroutine information.
- Update for PathMaster® version 2.3. 6/23/03 TMB

Content of This Manual

Definitions. Definitions for commonly used terms.

Notices and Warning. Basic safety practices are reviewed.

Getting Started. Instructions on establishing communication with the Dispensing System and installing the PathMaster® software.

Working with Materials. Overview on the basics of liquid dispensing.

Beginning Programming. Prerequisite information for using PathMaster®.

PathMaster® Overview. Basic description of features and tools of PathMaster® software.

Using PathMaster®. Detailed manual on using the PathMaster® software.

DMC Error Code. A list of error codes that may be encountered while using the Dispensing System.

Contents

Table of Contents

List of Tables

Definitions

Auto Cycle – Machine state where cycles are running.

Auto Purge – A machine function that automatically purges material after a predefined period of time.

Calibration Position – The location in the workspace where the X, Y, Z and W locations for the needle(s) is normalized.

Cycle Stop – Machine state where no action is occurring and the machine is at the standby position.

Depress – Press and hold for the duration of the operation.

Dispense Path – A continuous motion profile. The valve is on (dispensing or spraying) during the entire motion profile. Also known as a **Path** or **Motion Sequence.**

DMC – Language used to program the motion controller in the Dispensing System.

End Effector – The dispense head assembly. The end effector is moved by the axes.

Head – Dispensing, or spray valve (or any other part processing device).

Home Position – The (0, 0, 0, 0) location of the workspace. This position is determined by the location of the home sensors. It is NOT the same as the **Standby Position.**

Jog – One or more axes are command to traverse continuously at a specified speed until commanded to stop.

Light Tower – The light tower consists of three stacked lights, red, amber and green (top to bottom). It is used to indicate the status of the machine.

***Main* program file** – Text file containing the code that runs the Dispensing System during normal operations.

Motion Sequence – A continuous motion profile. The valve is on (dispensing) during the entire motion profile. Also known as a **Dispense Path, Coating Path** or **Path.**

Offline Programming - A manor of programming **Path Programs** without being connected to the Dispensing System. Known as FastPath™.

Path – A continuous motion profile. The valve is on (dispensing) during the entire motion profile. Also known as a **Dispense Path** or **Motion Sequence.**

PathMaster® – Windows® programming software. Used to create, maintain and download program files for the Dispensing System.

Press – Press and release.

Program – A collection (or series) of motion sequences.

Project – File containing the code for one or more programs.

Purge Position – The location in the workspace where the head moves to perform all auto purge operations.

PVA – Precision Valve & Automation, Inc. Precision Valve & Automation.

Solvent Cups – A container filled with an agent designed to prevent the spray and dispensing valves from clogging when idle for a specified period of time. Also known as **Solvent Rest.**

Solvent Purge – An Auto Purge performed after the valves move from the solvent cups prior to processing product.

Standby Position – The rest position for the end effector. The machine moves here after homing and after each cycle. This position is usually located near the start point for the program(s). It is NOT the same as the **Home Position.**

Terminal – A program used as a communication link between the controller and operator.

WSDK-1500 – Windows® Servo Design Kit 1500. This software is used to setup and tune the servo system.

Notices and Warnings

- Safety glasses, gloves, and long sleeved clothing are necessary precautions when working with automated industrial equipment.
- Read and understand all operating manuals before using this equipment.
- Do not disable the safety features of the machine.
- Lock-out and tag the air and power supplies before servicing or cleaning any part of this equipment.
- Do not remove any hose, either air or fluid, without relieving the pressure.
- Do not replace any hose with a hose of inadequate pressure rating.
- Use only replacement parts recommended or supplied by the manufacturer.
- Always remain clear of all moving parts when the system is in operation.

Getting Started

Necessary Skills

The Dispensing System operator must be familiar with Windows® and its most common features. This includes Notepad (or a similar text editing program), Explorer (or File Manager) and how to cut-and-paste information from one place to another. It is STRONGLY recommended that personnel be thoroughly versed in these subjects before attempting to program the machine.

Hardware & Software Requirements

PathMaster® requires a Pentium processor and at least 32 MB of RAM for Windows® 95, 98, NT, 2000, me, or XP operating systems.

Installing PathMaster®

To install PathMaster®, first close any applications that may be open. If the install is done via 3½" disks, take disk #1 of the PathMaster® installation disks and place it in the floppy drive, making sure it is secure. Run *setup.exe* and follow the instructions on the screen. For CD-ROM installations, insert the CD into the CD drive. Run *setup.exe* on the CD drive and follow the instructions on the screen.

NOTE: PVA recommends installing the software in its default directory (c:\Program Files\PVA).

Tutorials

In the *tutorials* directory of the PathMaster® CD-ROM are a number of audio/visual tutorials. These can be accessed via the *Help→Contents* option in PathMaster® or the *pathmaster.hlp* file.

NOTE: If the computer in use does not have a sound card or the card is not installed properly, the audio portion of the tutorials will not function.

Communications

The Dispensing System communicates with a computer using the EIA RS-232C standard. The computer is the Data Terminal Equipment (DTE Device) and the controller is the Data Communications Equipment (DCE Device). A programming port is located on the front of the machine. The controller baud rate and handshaking function are set with dip switches on the controller inside the Dispensing System enclosure. The settings for the controller and the computer must be the same.

WARNING **The computer must be at the same ground potential as the machine. Damage to the machine or computer may result if the ground potentials are different. Use the Dispensing System service outlet for computer power.**

DMC-1500 Dip Switch Settings

The main RS-232 port on the DMC-1500 controller must be configured as follows to communicate with the PathMaster® software.

Table 1 -- DMC-1500 Dip Switch Settings for PathMaster®

Switch	*Position*	*Description*
MRST	OFF	Master Reset Switch
1200	ON	Baud rate

9600 O	N	Baud rate
19200 O	FF	Baud rate
HSHK	ON	Hardware Handshaking Switch

NOTE: If hardware handshaking is enabled, and the program uses the message command and a computer is not attached to the Main RS-232 port, the controller eventually halts. A computer must be attached to the controller when handshaking is enabled and message commands are used.

Computer Settings

The following are the correct settings to communicate with the motion controller. PathMaster® automatically sets the data bits, parity and stop bits.

Table 2 – Communication Program Settings

Option	*Setting*
Baud rate	9600
Data bits	8
Parity	none
Stop bits	1

Uninstalling PathMaster®

To uninstall the software go to Windows® *Control Panel* and select *Add/Remove Programs*. The *Install/Uninstall* screen appears. Scroll down and highlight **PathMaster**. Then click on the *Add/Remove* button. PathMaster® is removed by Windows®.

As Windows® removes all the components associated with PathMaster®, it may query the operator concerning shared files. If in doubt, Precision Valve & Automation, Inc. recommends NOT deleting any shared files. Precision Valve & Automation, Inc. assumes no responsibility for any difficulties arising from the deletion of shared files during the uninstall procedure of PathMaster®.

NOTE: This process completely eliminates the PathMaster® software and all its components, including registry entries.

Multiple Dispensing System Issues

Unless a multiple machine cross-programming system was purchased with the Dispensing System, Precision Valve & Automation, Inc. Precision Valve & Automation **STRONGLY** recommends that customers not attempt to run programs developed with one Dispensing System on a second Dispensing System. While machines may appear similar, minor differences in the homing sequence, pneumatic actuators, etc. can be sufficient to cause an externally-developed program to damage a Dispensing System. Precision Valve & Automation, Inc. is not responsible for damages incurred in any such attempt.

Year 2000 Compliance

PathMaster® is compliant with and comprehends the year 2000 century date change. PathMaster® will not have any operational impediments, malfunction, cease to perform, generate incorrect or ambiguous data and/or produce incorrect or ambiguous results with respect to same-century and multi-century formulas, functions, date values and date-data interfaces.

If Something Goes Wrong . . .

Some problems encountered when using the Dispensing System are easy to identify and solve. Others require more extensive help. It is best to program in small increments, so problems appear quickly and can be diagnosed easily. Save work frequently during the programming process.

For non-immediate problems or to report suggestions, please email *pathmaster@pva.net*.

Calling Technical Support

The technical support staff is always available to help solve any problems. The phone number is (518) 371-2684. To assist in the troubleshooting process, it is best if as many of the following items are addressed before calling for help:

1) Note the serial number of the Dispensing System. The serial number can be found on the legend plate located on the front of the electrical enclosure.

2) Record all the information on the OIT or PC when the error occurred.

3) If the error was not serious, attempt to repeat the error. If the error does not repeat, the problem may have been operator generated.

4) Use a terminal screen to communicate with the controller. Most troubleshooting requires issuing commands directly to the controller.

5) A hard copy or email of the program in question may be requested by PVA. Please be prepared to send it. The PVA fax number is (518) 371-2688, or the customer service representative will provide an email address, if all parties are email capable.

Working with Materials

Overview

The Dispensing System workcell is designed to operate with many different materials in a variety of applications. Learning to use and program with these materials is both an art and a science. There are no concrete rules for an operator to follow; the best method for establishing settings for the system is trial-and-error. Once acceptable parameters are found it is easy to maintain those parameters over time.

System Components

Each part of the material delivery system must be adjusted and optimized for the selected material. In general, it is best to approach the problems in the order listed below.

Material Feed

Usually, material is moved through the system by one of two methods, either a pump or a pressure vessel. For either method, the operator's first task is to consult the manufacturer's material specifications and determine the appropriate settings for the material delivery system. If a pump is used on the system, the separate pump manual should be thoroughly read and understood to determine the best settings for the material. For a pressure vessel, if the pressure is too high the valve output will be excessive and inconsistent in flow and air may be forced into the material. Too little pressure provides insufficient output.

Dispense (Needle) Valve

The only direct adjustment for the needle valve is the stroke. Turning the knurled knob on the top of the valve counter-clockwise increases flow through the valve. A fine steady stream of material is all that is needed. Once a satisfactory setting is found, secure the stroke position with the locking nut. Once the locking nut is secure verify the valve flow rate before continuing.

Needle Selection

Experiment with different needle sizes to determine the best size for the system. If the needle is too large a drip develops at the end of the needle. To small a needle yields insufficient flow.

Spray Valve

Two adjustments are available for the spray valve: Valve stroke and atomizing air. The stroke controls the flow of material through the valve. Turning the knurled knob on the top of the valve counter-clockwise increases flow through the valve. Atomizing air is controlled by a pressure regulator located on the front of the machine. Turning this clockwise increases the air pressure. This pressure can only be adjusted while the valve is active. Once satisfactory settings are found for these items, secure the stroke position on the valve using the locking nut. Secure the regulator by pressing the cap or tightening the lock nut. Once the locking nut is secure verify the valve flow rate before continuing.

When first operating the machine, follow this list of instructions to adjust the spray valve:

1) Set the atomizing air to 0 P.S.I.
2) Take off the spray cap.
3) Turn the stroke down all the way.
4) Using the purge function in Manual mode, open the stroke to a few drops per second. It may be necessary to cycle the valve on and off while adjusting the stroke.

5) Replace the spray cap.

6) While purging, adjust the atomizing air until the spray is satisfactory. Test the spray pattern on scrap.

If the atomizing air is too high, the spray will be misty. If it is too low, there will be splatter. Thin, solvent based materials usually require as little as 0.5 P.S.I., while some silicones require as much as 15 P.S.I.

Extended Spray Cap

This cap is exclusive to the FCS100-ES valve. It is identified by its small long cylinder nozzle. This cap can reach into tight areas between tall components, were a very defined pattern is required.

Round Spray Cap

This provides a circular spray pattern. It is identified by its lack of external air ports. It works well for solvent based materials or where a smaller, more defined pattern is required.

Flat Spray Cap

The spray from this cap is rectangular/oval in shape. It is identified by the protruding atomizing air ports. It works best with non-solvent based materials and provides a wider spray path for increased coverage.

Programming

Once the physical parameters are successfully established for the delivery system, they should never be altered. The best method for changing the material output is to alter the program. In most cases, raising or lowering the speed of a dispense path is enough to change the material output to the desired level.

When programming with the dispense valve, lower the valve so that the end of the needle is close to the part surface, but not too close such that varying needle length tolerances will cause the needle to make contact with the surface of the product.

With the spray valve, a good rule of thumb is to start about ¾" (19 mm) above the product surface. With atomizing air, this should produce a spray width approximately ½" to ¾" (19 mm) wide. If necessary, adjust the spray height so the pattern on the product is consistent and uniform.

Beginning Programming

Overview

This section provides important information every operator must know before programming the Dispensing System. A thorough understanding is recommended.

Planning Path Programs

It is best to plan the path program on paper before starting on the machine. Break the planned program into individual paths and number each path and the points within it, along with which valve is active and what pneumatic operations must be performed. The path numbers and point numbers should correspond to the order in which the program proceeds. This documentation is very useful when debugging programs.

Breaking the path program into smaller segments is wise and provides three advantages. First, each segment can have different on, off and speed parameters. Second, the operator can focus on programming and debugging one segment at a time. Third, if one segment of the program must be changed, the remaining segments are not affected. This reduces debugging time and makes the program maintainable.

When programming, the operator should comment the program as needed to enable anyone to follow the logic. Again, this decreases debugging problems and saves time in the long run.

NOTE: If a stop or dwell must be added at one of the points after a path is completed, then the path must be broken into two paths or entirely reprogrammed.

Incorrect Valve Usage

When programming or operating the Dispensing System, the valves should **NEVER** be used for moving components or boards. Precision Valve & Automation is not responsible for damages incurred from using the valves in an inappropriate manner.

Inserting Valve Commands into Programs

Pneumatic positions (head up/down, rotary selection) are not automatically programmed by PathMaster® and there is no communication between the Dispensing System and PathMaster® concerning the active valve or its pneumatic position. Therefore, it is the responsibility of the operator to select the appropriate valve within PathMaster® and insert the necessary pneumatic commands into the program after a path has been completed.

It is important these commands are not inserted at incorrect locations. In general, try to follow these rules:

- Program each segment with the corresponding valve slide in the down position.
- Actuate a valve rotary before lowering a valve slide.
- Move the XY(W) axes into position prior to actuating a valve slide or valve rotary.
- Insert valve slide down and valve rotary B commands before any segment(s) that require them.
- Insert valve slide up and rotary A commands once finished with the valve.
- Raise a valve slide before returning a rotary to A.
- Insert all the code for each segment after completing it.
- If suddenly changing valves, insert a non-dispense move on the Z axis to 0, to allow room for the new valve to lower. (See Inter-Path Movement on page 18 for more detail.)

Inter-Path Movement

When programming the Dispensing System via PathMaster® it is easy to determine the movement, point-to-point, within a path program via the playback feature. However, it is more difficult to gange movement between segments. After completing a segment, the Dispensing System immediately moves the axes to the start point of the next segment. If there are obstacles in the way, the machine does not know this, since this route was not tested and programmed intentionally.

There are different ways to combat this problem. The best solution is to follow the recommended procedure and map out the path program to allow for direct movements between segments. If that was not done, or obstacles cannot be avoided, then the operator should insert 'safety' moves of the Z axis to avoid inadvertently hitting anything. This is accomplished by programming a 'Z only' move, with the Z-axis target set to 0.

It is ultimately the operator's responsibility to ensure no combination or sequence of path segments are harmful to the machine or any product the operator is running.

Main Program Modifications

Sometimes it is necessary to make changes in the main program that runs the Dispensing System. Usually it involves setting up points for the machine to use. If the operator must do this, it is imperative to download the corrected main file properly to avoid any problems. Open the *Main* program using a text editor, such as Windows® Notepad or Winpad.

Common Main Program Changes

There are a few sets of points that commonly need changing: Standby position, purge position, solvent cup position, and calibration position. In the main program these settings are located in the Machine Specific Information section (near the end of the file), an example of which is shown below:

```
REM !!!! Machine-Specific Information !!!!
#IMACH;MT 1,1,1,1
CE 0,0,0,0;FSTX=20000;SLWX=10000;FSTY=20000;SLWY=10000
FSTZ=10000;SLWZ=5000;FSTW=10000;SLWW=5000
KNHEAD=3;A_HEAD[1]="FCS100";R_HEAD[1]=0
A_HEAD[2]="FC100 ";R_HEAD[2]=1
A_HEAD[3]="DISPSE";R_HEAD[3]=1
PT_APG[0]=80000;PT_APG[1]=65000;PT_APG[2]=0;PT_APG[3]=3000
PT_SOL[0]=80000;PT_SOL[1]=65000;PT_SOL[2]=0;PT_SOL[3]=3000
PT_CAL[0]=15000;PT_CAL[1]=15000;PT_CAL[2]=500;PT_CAL[3]=2000
PT_SBY[0]=25000;PT_SBY[1]=25000;PT_SBY[2]=250;PT_SBY[3]=3500
AP_EN=0;AP_LEN=2000;AP_TIME=30000;PNTO=4000;LT_EN=1;AC_TMR=1
SLP_TM=30000;SO_EN=0;LLA_EN=0;LLB_EN=0
#TUNE;AC*=325000;DC*=300000;SP*=120000;VA*=70000;VD*=70000
BL -4000,-4000,-1000,-1000
FL 83000,85000,15000,30000;TL*=9.9999
KD 67.99,82.43,76.09,50.00
KP 5.66,6.75,8.38,5.00
KI 0.25,0.19,0.34,0.50;EN
```

The following tables display the command variables that an operator may wish to change.

Table 3 – Coordinate System Locations

	Axis			
Locations	*X*	*Y*	*Z*	*W*
Auto Purge Location	PT_APG[0]	PT_APG[1]	PT_APG[2]	PT_APG[3]
Solvent Cup Location	PT_SOL[0]	PT_SOL[1]	PT_SOL[2]	PT_SOL[3]
Calibration Location	PT_CAL[0]	PT_CAL[1]	PT_CAL[2]	PT_CAL[3]
Standby Location	PT_SBY[0]	PT_SBY[1]	PT_SBY[2]	PT_SBY[3]

Table 4 – Variable Explanations

Variable	*Explanation*
AP_EN	Default value for auto purge. 1=on, 0=off.
AP_LEN	Length of auto purge, in milliseconds.
AP_TIME	Time between auto purges, in millesends.
SLP_TM	Sleep timer value for solvent rest, in millesends.
SO_EN	Solvent rest enable / disable. 1=enable, 0=disable.

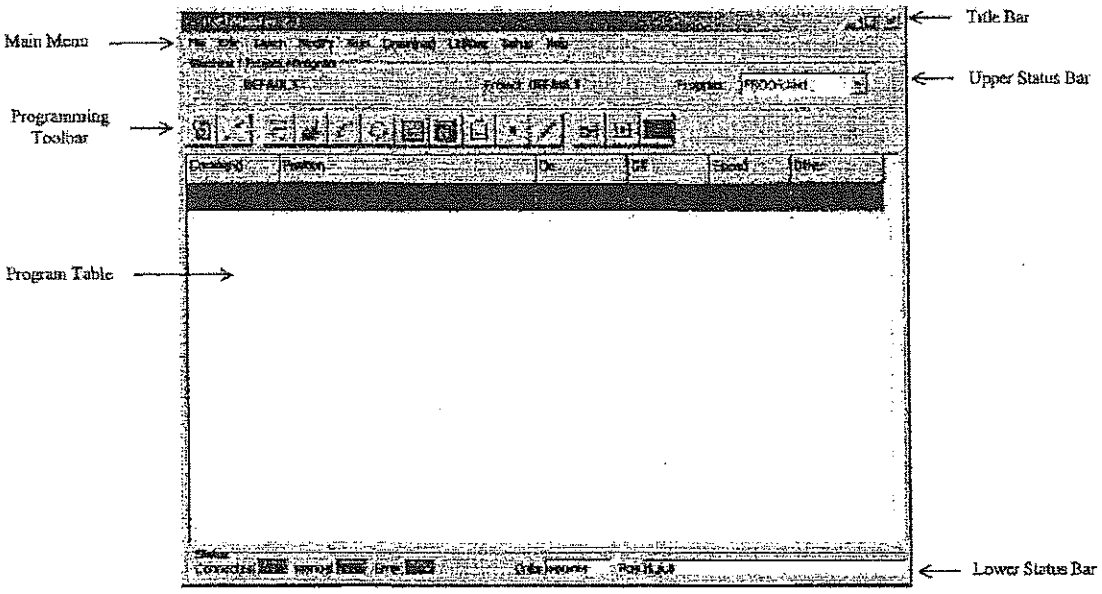
Once *Main* program modifications have been made, the new program must be downloaded to the controller using the PathMaster® Download -> Main function.

PathMaster® Overview

General

Precision Valve & Automation, Inc. has developed a Windows® application to facilitate the development, maintenance and execution of programs for the Dispensing System. PathMaster® combines the ease of use in typical Windows® applications with the specific functionality necessary for programming the Dispensing System.

PathMaster® Window



Upper Status Bar

The upper status bar displays the active machine configuration, current project file and current path program. The current path program can be changed via the drop-down list box.

Lower Status Bar

The lower status bar shows the current status of the Dispensing System. Whether or not, the PC is communicating with the Dispensing System is reflected in the 'Connected' display. The 'Manual' display indicates if the machine is in Manual mode. The 'Error' display reports if the machine is currently in a

state of error. The 'Units' field is the measurement system in use when programming, and can be altered in the Setup section of PathMaster®.

NOTE: In order to teach path programs online, PathMaster® must be connected, in Manual mode, and not in a state of error.

Main Menu

File Menu

- **Machine** – Select a machine configuration.
- **New** – Create a new project.
- **Open** – Open an existing project or subroutine.
- **Close** – Close the current project.
- **Delete** – Delete the current project, or current program.
- **Save** – Save the current project.
- **Save As** – Save the current project under a different name.
- **Print** – Print the current program, or print the entire compiled program.
- **Database** – Backup or restore the PathMaster® database.
- **Import** – Import a project, program, or subroutine.
- **Export** – Export a project, program, or subroutine.
- **Exit** – Exit the application.

Edit Menu

- **Program** – Edit the program name, auxiliary code, or background image.
- **Undo Delete** – Undo the last Delete operation.
- **Cut** – Remove highlighted path segment(s) and copy to the clipboard.
- **Copy** – Copy highlighted path segment(s) to the clipboard.
- **Paste** – Copy path segment(s) from the clipboard and insert it into the program.
- **Delete** – Delete highlighted path segment(s).
- **Select All** – Select all path segments from the displayed program.

Teach Menu

- **Move** – Code a move to a specific location.
- **3D Path** – Teach a 3D path segment and specify valve activity.
- **2D Path** – Teach a 2D path segment and specify valve activity.
- **Dot** – Dispense at a defined point for a length of time and specify valve activity.
- **Area** – Teach an "Area" path segment that covers a rectangular shape.
- **Circle** – Teach a circular path segment and specify valve activity.
- **Arc** – Teach an arc path segment and specify valve activity.
- **FastMask** – Teach a FastMask™ path segment (specify keep out areas).
- **Polyline** – Teach a path segment consisting of 2D, circle, and arc path segments
- **Subroutine** – Create a new or insert an existing PathMaster® subroutine.
- **Dwell** – Teach a delay between path segments in seconds.
- **I/O** – Reference inputs or outputs within the program.
- **Head** – Insert valve functions (up/down, rotary, etc.).
- **Comment** – Insert comments into the path program.
- **DMC Command** – Write DMC machine code into the path program.

Modify Menu

- **Properties** – Modify properties of selected path segment.
- **Offset** – Apply an offset to any axis for selected path segments, or the entire program.
- **Speed** – Modify speed for selected path segments, or the entire program.

- **Valve Parameters** – Modify parameters for selected path segments, or the entire program.
- **Subroutine Call** – Change a subroutine call for the selected path segments.

Run Menu

- **Selection** – Run (playback) the highlighted path segment on the Dispensing System.
- **Program** – Run (playback) the current program on the Dispensing System.

Download Menu

- **Project** – Download the current project file.
- **Main** – Download the *Main* operating program for the Dispensing System.

NOTE: The operator must activate the EMERGENCY STOP button when downloading files to the controller!

Utilities Menu

- **View FastPath** – Open the FastPath™ window for offline programming.
- **Measure Distance** – Calculate the position between two points.
- **Machine Debugger** – An array of tools useful for debugging.
- **Refresh Communications** – Issue an attempt to reestablish communication with the workcell.
- **Jog Toolbar** – Toolbar used to jog the head from PathMaster®
- **View Tools** – Enable programming toolbar.
- **Path Preview** – Graphic view of the selected path segments.
- **Show Code** – Show machine code for selected path segments.

Setup Menu

- **Machine Parameters** – Setup machine parameters for the current machine profile.
- **Passwords** – Set password for downloading and saving projects.

Help Menu

- **Contents** – PathMaster® online help.
- **Commands** – Online help manual for the Galil DMC-1500 controller.
- **About** – Information about PathMaster®, including release version.

Right-Click Menu

Using the right mouse button while highlighting a function accesses this menu.

Teach

- **Move** – Code a move to a specific location.
- **3D Path** – Teach a 3D path segment and specify valve activity.
- **2D Path** – Teach a 2D path segment and specify valve activity.
- **Dot** – Dispense at a defined point for a length of time and specify valve activity.
- **Area** – Teach an "Area" path segment that covers a rectangular shape.
- **Circle** – Teach a circular path segment and specify valve activity.
- **Arc** – Teach an arc path segment and specify valve activity.
- **FastMask** – Teach a FastMask™ path segment (specify keep out areas).
- **Polyline** – Teach an path segment consisting of 2D, circle, and arc path segments
- **Subroutine** – Create a new or insert an existing PathMaster® subroutine.
- **Dwell** – Teach a delay between path segments in seconds.
- **I/O** – Reference inputs or outputs within the program.
- **Head** – Insert valve functions (up/down, rotary, etc.).
- **Comment** – Insert comments into the program path
- **DMC Command** – Write DMC machine code into the path program.

Modify

- **Properties** – Modify properties of selected path segment.
- **Offset** – Apply an offset to any axis for selected path segments, or the entire program.
- **Speed** – Modify speed for selected path segments, or the entire program.
- **Valve Parameters** – Modify parameters for selected path segments, or the entire program.

Run

- **Selection** – Run (playback) the highlighted path segment on the Dispensing System.
- **Program** – Run (playback) the current program on the Dispensing System.

Move To First Point – Move to the first point of the selected path segment(s).

Show Code – Show machine code for selected path segment(s).

Path Preview – Graphic view of the selected path segment(s).

Cut – Remove highlighted path segment(s) and copy to the clipboard.

Copy – Copy highlighted path segment(s) to the clipboard.

Paste – Copy path segment(s) from the clipboard and insert it into the program.

Programming Toolbar

The programming toolbar provides quick access to the most frequently used programming tools.

Programming Tools

Programming tools are used to create path segments, which make up a path program. PathMaster® contains a variety of useful programming tools which can be used to create 2 dimensional and 3 dimensional path motion. Many of the most commonly used tools are located on the toolbar, while the less frequently used tools can be accessed from the Teach menu.

Comment – Insert comments into the program

Move – Code a move to a specific location.

2D Path – Teach a 2D path segment and specify valve activity.

3D Path – Teach a 3D path segment and specify valve activity.

Arc – Teach an arc path segment and specify valve activity.

Circle – Teach a circular path segment and specify valve activity.

Area – Teach an "Area" path segment that covers a rectangular shape.

FastMask – Teach a FastMask™ path segment (specify keep out areas).

PolyLine – Teach a path segment consisting of 2D, circle, and arc path segments

Dot – Dispense at a defined point for a length of time and specify valve activity.


Head – Insert valve functions (up/down, rotary, etc.).


Step Over Program – Step to the previous, or next path segment.


Play – Play back the selected path segments.


FastPath – Open the FastPath™ window for offline programming.

PathMaster® Database

General

The PathMaster® application utilizes a flexible database structure to store all parameter and program information. The database structure allows for a central storage location for all data, which can easily be backed up and restored. When projects and path programs are saved, the user will save them under a name of there choice, however, the name that they give there projects and path programs will not be visible to the user as a file on their hard drive. The project and program names are stored as records in the database rather than the conventional file structure used in previous versions of PathMaster®. Precision Valve & Automation **strongly** recommends that the entire database be backed up before and after any changes are made to projects or programs. Precision Valve & Automation is not responsible for any lost data or production time due to improper database backup procedures.

Multiple Dispensing Systems

The database structure employs a system, which will allow as many Dispensing System configurations as needed. In a production environment where multiple machines with varying configurations are utilized, a single PathMaster® database can use and maintain the configurations for each of these machines.

Machine Configuration

Pathmaster® will utilize the default machine configuration on startup unless there are multiple machine configurations stored in the database. If there are multiple machine configurations available, PathMaster® will prompt the user to select the machine or machine configuration that they will be using.

Path Programs

A path program is a collection of path segments that make up a dispensing or spray program. Path segments are made up of any combination of programming functions. Each path program can contain a unique name of 12 characters or less. The path program name is displayed on the workcell OIT while running product.

Project Files

PathMaster® project files can be thought of as a collection of storage bins for up to thirty path programs. Each one of these 30 bins can hold one path program. When a project file is downloaded to the Dispensing System, all 30 of the storage bins are downloaded to the workcell controller, even if some are empty. The empty bins simple do nothing if they are selected to run.

Using PathMaster®

Starting PathMaster®

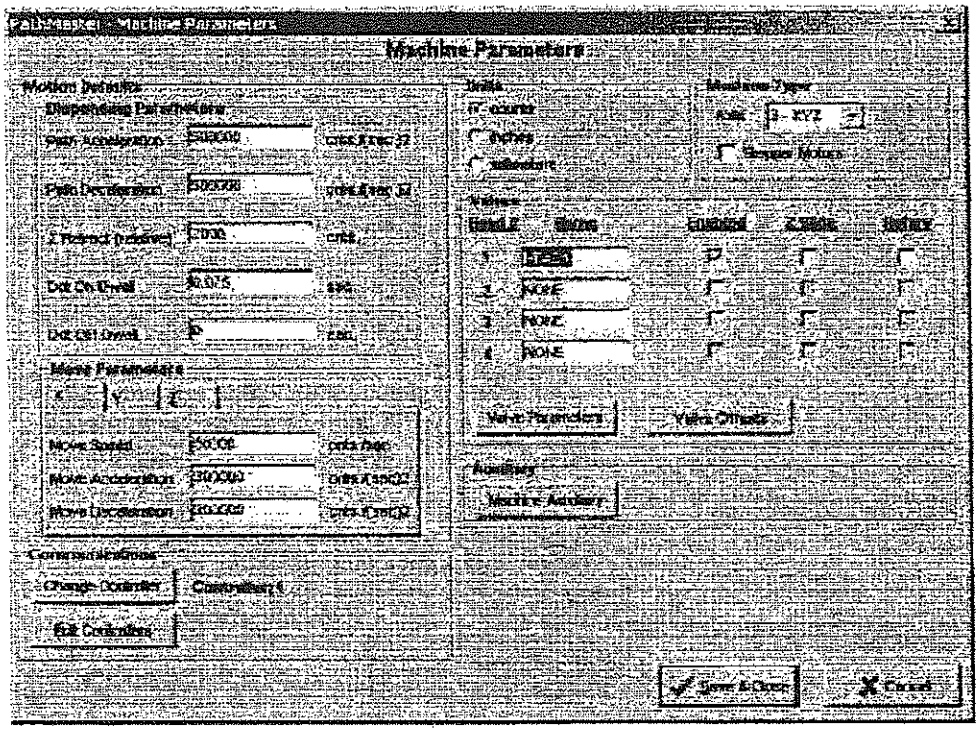
The first time you run PathMaster® it will need to be configured to run properly with the Dispensing System. To start the PathMaster® application, locate and double-click the PathMaster® icon. The Select Project dialog box will display. Click the *Create a New Project* radio button and select *OK*. An information box will appear indicating that no communication settings were found for your controller. This is normal for the initial startup. Click the *OK* button to continue.

Configuring PathMaster®

Before PathMaster® can be used, it must be configured to suit the machine and machine application. Communication parameters must also be configured to allow PathMaster® to interact with the Dispensing System.

Machine Parameters

The machine parameter form is used to set attributes specific to the software as well as the hardware. Machine parameters are unique to the machine profile. The settings on the machine parameter form apply only to the current machine profile. The current machine profile is displayed in the upper status bar of the main PathMaster® window.



Dispensing Parameters

The dispensing parameters are the default parameters for all coordinated path motion. These parameters can be modified within each programming function for each path segment.

- **Path Acceleration** - Set default acceleration for all coordinated motion.
- **Path Deceleration** – Set default deceleration for all coordinated motion.
- **Z-Retract** – Set default relative z retract for Dot function.
- **Dot On Dwell** - Set default valve on time for Dot function.
- **Dot Off Dwell** - Set default valve off time for Dot function.

Move Parameters

The move parameters are the default parameters for all independent path motion for each axis of motion.

- **Move Speed** – Set default move speed for all independent path motion.
- **Move Acceleration** – Set default acceleration for all independent path motion.
- **Move Deceleration** – Set default deceleration for all independent path motion.

Units

Select the preferred measurement system (encoder counts, millimeters, inches).

Machine Type

Configure PathMaster for a two, three, or four axis gantry. Check the *Stepper Motors* box if you are running PathMaster® on a PVA250™, PVA750™, PVA2000C™, or any other open loop stepper PVA Dispensing System.

Valves

Name and configure valve heads as they are used throughout the software. The names are located in the Configuration section of the Operating Guide, along with the options present for each valve. The 'Enabled' box should be checked for all the valves present on the machine. 'Z-Slide' and 'Rotary' should be checked if they are installed.

Valve Parameters

- **On Delay Wait** – The pause after turning the valve on but before starting the path.
- **Off Delay Wait** – The pause after finishing the path and turning the valve off but before moving to the next point.
- **On Delay Distance** – Distance the path traveled before turning the valve on.
- **Off Delay Distance** – Distance the path traveled when turning the valve off, before the path finishes.
- **Speed** – Vector speed for any programming function using the corresponding valve.
- **Valve Height** – Distance from the surface of the product to the lowest point of the valve as taught using the valve offset function (***offline programming only***).
- **Area Spacing** – Distance between runs when executing an Area path.

Valve Offsets

Valve Offset is a wizard used to step through the configuration process of setting the offsets between each valve and a pointing device. These offsets are used for offline program, as well as for online programming with a pointing device.

Machine Auxiliary

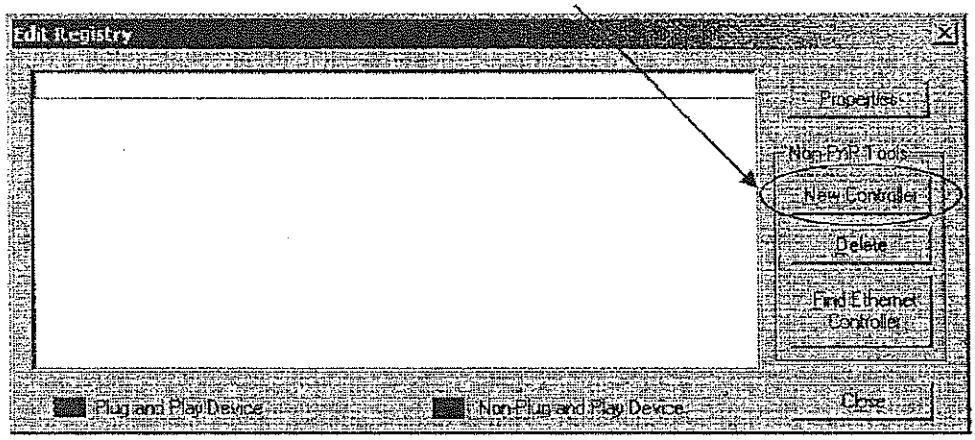
The machine auxiliary function is used to hardcode custom software options into the machine software. This function is typically preprogrammed by Precision Valve & Automation and provided to the customer with specific instruction on how to use it.

Communications

Communications is used to configure the RS232 communication settings between the computer and the Dispensing System. PathMaster® uses control handles to store all communication settings for a machine. A control handle can be thought of as a record in a database that has multiple fields in which to store vital pieces of information. The information in the control handles is stored in the Windows® registry. PathMaster® can have multiple control handles configured, but can have only one control handle selected at a time.

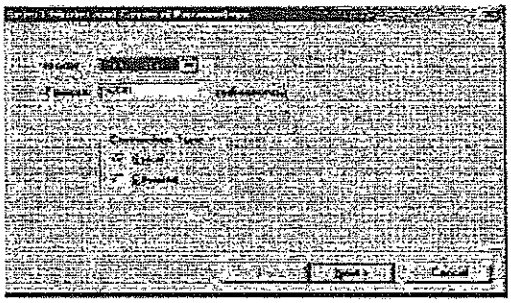
To configure communications, click the *Edit Controller* button on the Machine Parameters form. If a message appears indicating that PathMaster® could not find any controllers in the Windows® Registry, click *OK*. This simply means that no control handles have been configured yet.

When the Edit Registry window appears, click *New Controller*.



Select the controller model installed in the Dispensing System from the table below:

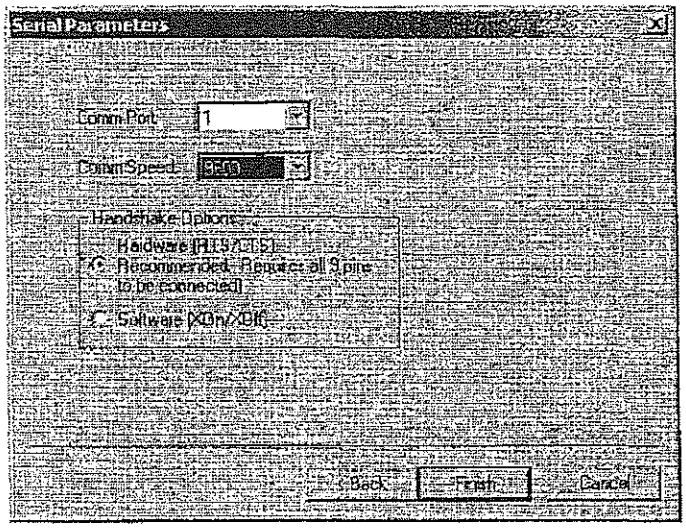
PVA Workcell	Controller Model
PVA250 D	MC-2100
PVA550 D	MC-1500
PVA750 D	MC-2100
PVA1000 D	MC-1500
PVA2000 D	MC-1500
PVA2000C D	MC-2100
PVA3000 D	MC-1500
All other's	DMC-2100



Use the default Timeout value for all controllers and Serial for Connection Type. ***NOTE: Not all controller models require configuration of Connection Type.***

- Click *Next* -

Select the communication port that your PC is using:



The Comm. Speed should match the comm. speed set on the controller. This is set to 9600 by Precision Valve & Automation prior to shipping.

Select hardware handshaking.

- Click *Finish* -

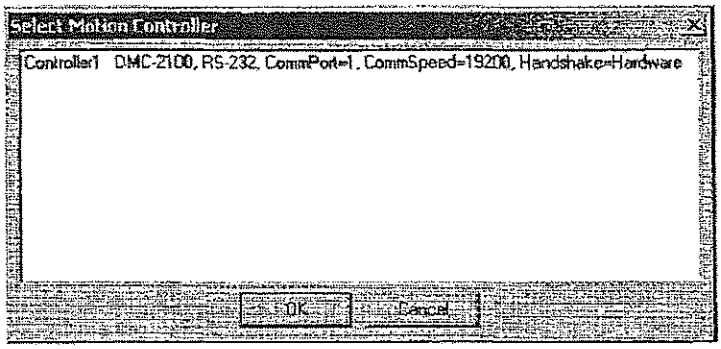
Acknowledge the dialog box stating that the controller has been added.

- Control handle properties can be modified by highlighting the controller and clicking *Properties*.
- Multiple control handles can be added.
- Control handles can be deleted by clicking the *Delete* button.

- Click *Close* -

Once one or more control handles have been created, you must select the control handle that PathMaster® will use to communicate with the Dispensing System. To select a control handle:

- Click the *Change Controller* button on the Machine Parameters form.



- Select the control handle to be used.
- Click the *OK* button.

Saving Machine Parameters

Once all machine parameters have been set, click the *Save & Close* button to save the parameters and return to the main PathMaster® window.

Database Backup and Restoration

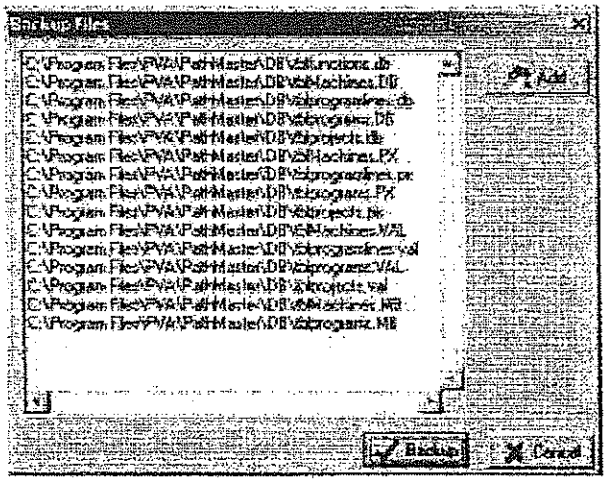
It is extremely important that the PathMaster® database be backed up properly. Precision Valve & Automation **strongly** recommends that the entire database be backed up (manually) before and after any changes are made to projects or programs. Precision Valve & Automation is not responsible for any lost data or production time due to improper database backup procedures.

Automatic Backup

PathMaster® will perform an automatic backup of the entire database each day that PathMaster® is executed. PathMaster® utilizes a rolling ten day automatic backup scheme, therefore, backup file will be stored for the last ten days that PathMaster® was executed. All automatic backups are stored in the Db\Daily subfolder of the PathMaster® application folder. The default location of these files is "c:\program files\pva\pathmaster\db\daily".

Manual Backup

A manual database backup is by far the safest method. This method requires a conscious effort by the user, and therefore, should be part of their programming procedure. To perform a manual database backup, select the File -> Database -> Backup option from the main menu. Save the project if prompted to do so. When the Backup Files form opens, click the *Backup* button.



NOTE: Additional files can be added to the backup by clicking the Add button and selecting the file. This is not normally necessary for a complete PathMaster® database backup.

The Save As dialog box opens. Select a destination and a filename for the backup file (the backup will only be 1 file). The backup file extension will be 'bck'. Click the *Save* button. The PathMaster® database backup is complete.

Database Restoration

To restore the PathMaster® database, select the File -> Database -> Restore option from the main menu. You can restore a *.bck (standard backup) or *.abck (automatic backup) file using this option.

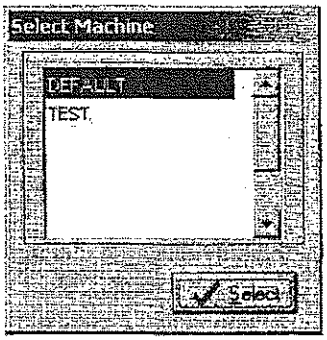
WARNING: Restoring a PathMaster® database will completely overwrite all existing data prior to the restore operation. If you are attempting to restore partial data, a database restore is not the correct procedure.

Once the file dialog box opens, select the location and file you wish to restore. Click the *Open* button. Once the restore successful message displays, click *OK*. Restart PathMaster®.

Important Reminders

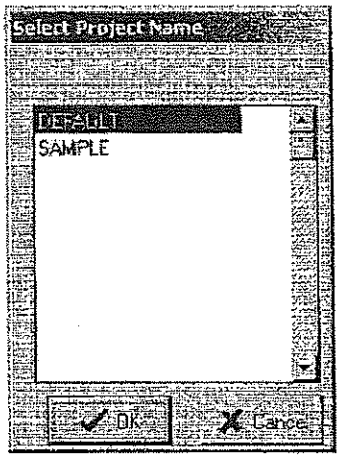
- **Inserting Code** – When the operator uses PathMaster® programming functions to insert code, the code is placed at the current highlighted location on the screen. It is the operator's responsibility to ensure the proper area is highlighted to accommodate the new path.
- **Inserting Valve Commands** – Commands to move the heads or valves are NOT automatically inserted into PathMaster® the path programs. If the operator needs a head to change position (up/down, rotary) the appropriate command must be inserted manually via the Head programming tool. Please read Inserting Valve Commands into Programs on page 17 for more information on this subject.
- **Downloading** – The operator must activate the *EMERGENCY STOP* button when downloading files to the controller.

Machine Selection



If more than one machine configuration exists in the PathMaster® database, it is necessary to select the appropriate machine before programming. This option presents itself whenever PathMaster® begins and there are multiple machine profiles. Projects are assigned to particular Dispensing Systems, so it is necessary, when changing machines, to select a new project.

Project Selection



It is necessary to select the appropriate project before programming. This option presents itself on startup, whenever PathMaster® changes the current machine setting or the operator wishes to open a different project.

- **OK** – Select the highlighted project as current.
- **Cancel** – Exit this function without making changes.

Reading a Program

The PathMaster® program display is arranged in a table format. Use the chart below to determine the purpose of the text that appears in each field.

COLUMN	USE	EXAMPLE	EXPLANATION
Command	Programmed command. ***NOTE: A command uses all the lines below it until another command reference appears in the command column.***	DOT	Dot program.
		LINE(3D) 3	D Line
Position C	oordinates.	4555,3000,760	Cartesian coordinates for current point.
On	Valve or I/O on.	(1)W.5	Activate head 1, valve on time of .5 seconds.
		(2)D300	Activate head 2, valve on distance of 300 counts.
		I49	Wait for input 49 to be on.
		O32	Turn on output 32.
Off	Valve or I/O off.	W.75	Deactivate the path's

			head 1, valve off time of .75 seconds.
		D500	Deactivate the path's head, valve off distance of 500 counts.
		I51	Wait for input 51 to be off.
		O35	Turn off output 35.
Speed	Path speed.	2000	Path speed of 2000 counts/second.
Other	Varies according to path.	Z=250	Z axis relative move of 250 counts after completing a dot path.

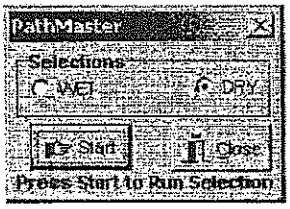
Playback

Paths can be played back using two methods in addition to downloading and running the entire program via the Dispensing System:

1) Highlight an individual path and select *Run→Selection* from the drop-down menu or the right-click menu.

2) Play an entire program by selecting *Run→Program* from the drop-down menu or the right-click menu.

Before playback begins, the user will be prompted to select a Wet or Dry playback.



Wet playback activates the valve(s) while running the path. Dry playback does not activate the valve(s).

Edit Windows

Path tools with editing capability allow the operator to change a path segment once it has been created. Examples of edit windows appear in each path section that is editable. The coordinates box appears in the upper left hand corner of the edit window, showing all the coordinates programmed. The following icons and buttons appear in edit windows to facilitate path editing:

Move to Point – Move to the point highlighted in the coordinates box.

Edit Point – Edit the point highlighted in the coordinates box.

 **Previous Point** – Move to the preceding point in the path (if one exists).

 **Next Point** – Move to the next point in the path (if one exists).

 **Insert Point** – Insert a new point BEFORE the current highlighted point.

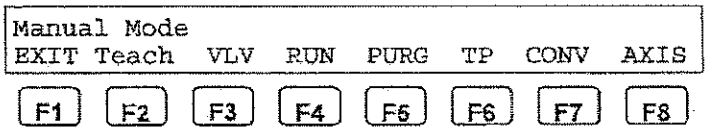
 **Delete Point** – Delete the highlighted point.

 **Append Point** – Add a point to the end of the path.

Interacting With the Dispensing System

For PathMaster® to operate properly it must work in concert with the Dispensing System. The Dispensing System must be in Manual mode in order to teach a path program online with PathMaster®. If in Cycle Stop, the Dispensing System can be placed into this mode by pressing F4. For more information on using the Dispensing System apart from PathMaster® please consult the separate Operation and Maintenance Manual within the Operating Guide.

Manual/Jog/Teach Mode



[F1] EXIT – Leave Manual/Jog/Teach mode and return to Cycle Stop.

[F2] TEACH – Program the current point.

[F3] VLV – Switch to Valve Selection.

[F4] RUN – Run singular cycles of the current program.

[F5] PURG – Actuate the current valve.

[F6] TP – Momentary switch that displays the current position of the head.

[F7] CONV – Switch to Conveyor Control.

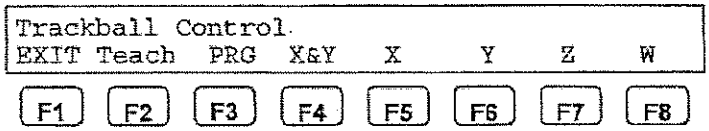
[F8] AXIS – Switch to Trackball Control.

NOTE: Playback of a path is only possible if the operator is in Manual mode or one of its sub modes.

Valve Selection, Conveyor Control and Trackball Control are the other areas accessible from Manual mode. Valve Selection selects which valve is currently operational on the Dispensing System. Conveyor Control operates the board stop and the conveyor.

Trackball Control

(All models except PVA250™, PVA750™, PVA2000C™)



Trackball Control allows the operator to switch the active axis on the trackball.

[F1] EXIT – Leave Trackball Control and return to the previous mode.

[F2] TEACH – Program the current point.

[F3] PURG – Actuate the current valve.

[F4] X&Y – Operate the X and Y axes simultaneously.

[F5] X – Operate only the X axis.

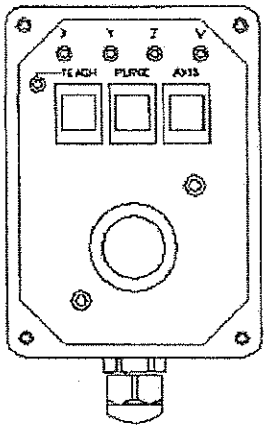
[F6] Y – Operate only the Y axis.

[F7] Z – Operate only the Z axis.

[F8] W – Operate only the W axis.

Teach Pendant

PVA550™, PVA2000™, and PVA3000™ are equipped with a teach pendant which has a trackball, teach button, purge button, axis selection button, and LED indicators for selected axes and teach function.



TRACKBALL – The trackball allows the operator to jog each axis independently or X and Y together.

Teach – The teach button mimics the teach button found on the Dispensing System OIT in that it will register the gantry position back to PathMaster® when teaching a motion profile.

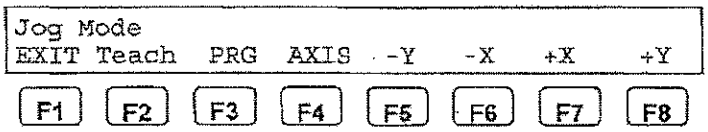
Purge – The purge button mimics the purge button found on the Dispensing System OIT in that it will purge material from the active valve.

Axis – The axis button allows the operator to toggle through the available axis configurations. Typical configurations are X only, Y only, Z only, W only, and X & Y together.

LED's – The X, Y, Z and W LED's represent the selected axis configuration. The teach LED indicates a successful response from PathMaster® when a position is taught. The teach LED is accompanied by a 'beep' from the light tower buzzer.

OIT Jog Control

(PVA250™, PVA750™, PVA2000C™ models only)



OIT Jog Control allows the operator to jog the gantry via the OIT function keys to perform teach functions.

[F1] EXIT – Leave OIT Jog Control and return to the previous mode.

[F2] TEACH – Program the current point.

[F3] PURG – Actuate the current valve.

[F4] AXIS – Toggle axis control between X, Y and Z.

[F5] -Y – Jog the Y axis in the negative direction.

[F6] -X – Jog the X axis in the negative direction.

[F7] +X – Jog the X axis in the positive direction.

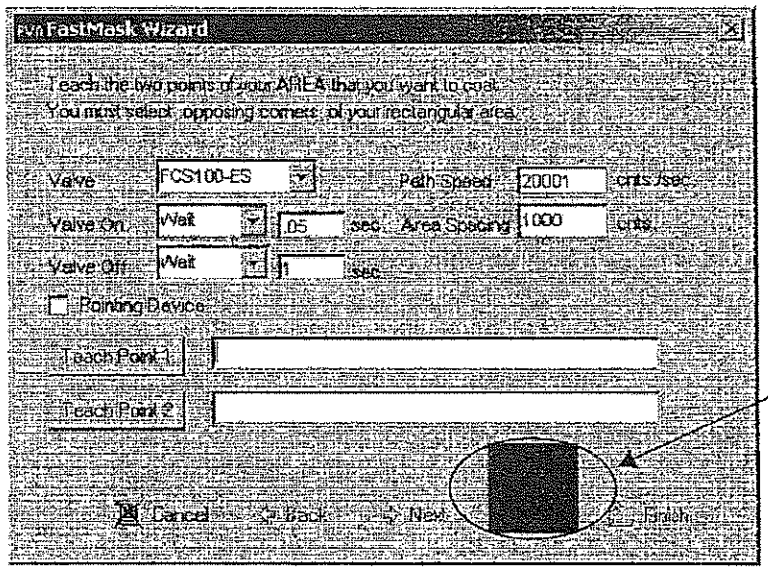
[F8] +Y – Jog the Y axis in the positive direction.

To jog an axis, press and hold the function key that corresponds to the axis and direction of motion desired. Once the axis is in motion for approx. 1 sec, the speed will increase by a factor of 15.

TracMouse™

PathMaster® is equipped with the capability to jog the workcell gantry using a pointing device with your computer, such as a mouse or trackball. This feature is especially useful on PVA250™, PVA750™, and PVA2000C™ machines that are not equipped with a teach pendant or built in trackball.

The TracMouse™ has an activation pad or TracPad inside of each PathMaster® programming tool. The TracPad™ is the dark gray square or rectangle located on each tool form. Left click the TracPad™ to activate the TracMouse™. To move the gantry, press and hold the left mouse button while dragging the mouse cursor on the TracPad™. To switch between axes, right click the TracPad™ until the desired axis combination is displayed in the upper left hand corner of the activation pad. Double click on the TracPad™ to teach a point while the TracMouse™ is active.



Pneumatic Commands

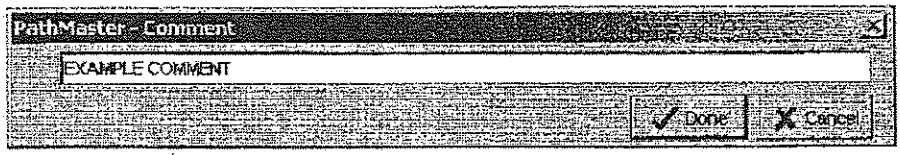
Pneumatic positions (head up/down, rotary selection) are not automatically programmed by PathMaster® and there is no communication between the Dispensing System and PathMaster® concerning the valves pneumatic position. Therefore, it is the responsibility of the operator to select the appropriate valve within PathMaster® and insert the necessary pneumatic commands into the edit window after a path has been programmed. Physically, the pneumatics are operated from the Valve Selection screen on the Dispensing System.

Programming Tools

Adding Comments

It is a good practice to add comments to each path program in a manor in which anyone that views the path program can understand what the program is doing. All comments are stripped from the program on compilation; therefore, they do not use any controller memory.

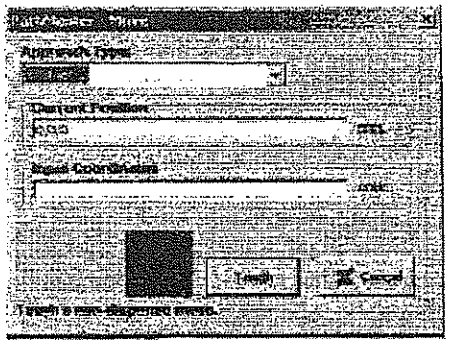
Comment Edit Window



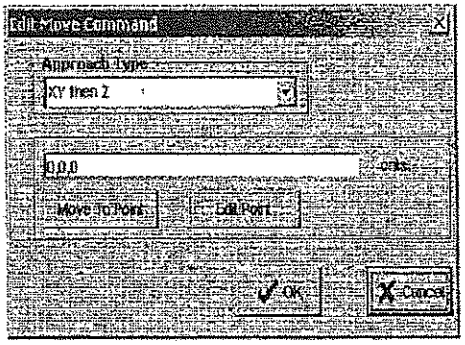
Move

Programmed

Teach Screen



Edit Screen



This tool allows the operator to program an absolute move. This is a non dispense move.

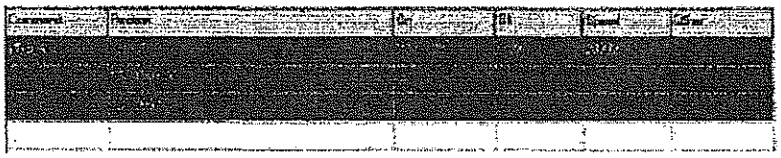
- **Approach Type** – Select the order of movement for the function. "XY Only" means the controller moves along the X and Y axes simultaneously. "XY then Z" means the controller first moves X &Y and once that motion is complete it moves Z. The total list of options:

XY only	XYZ
X only	XYW
Y only	XYW then Z
Z only	W only
XY then Z	XY then W then Z

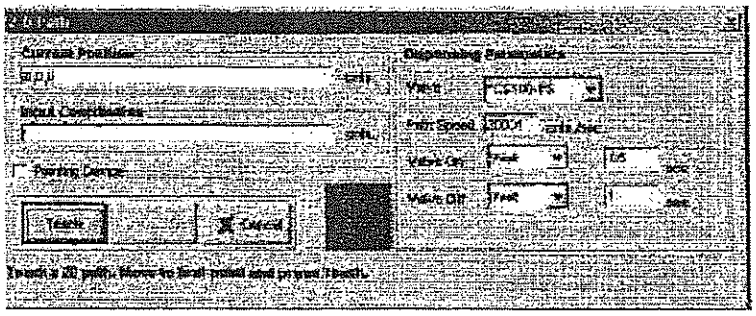
- **Current Position** – If there is communication established with the controller, the current position appears in the text box. Use the trackball on the Dispensing System to change the position.
- **Input Coordinates** – Manual entry of target position.
- **Teach** – Record current position and add to the program. Equivalent to the F2 key on the Dispensing System.
- **Teach Position** – Record current position and alter program to use it. Equivalent to the F2 key on the Dispensing System.
- **Teach Coordinates** – Record entered position and alter program to use it.
- **Cancel** – Quit without altering the program.

2D Path

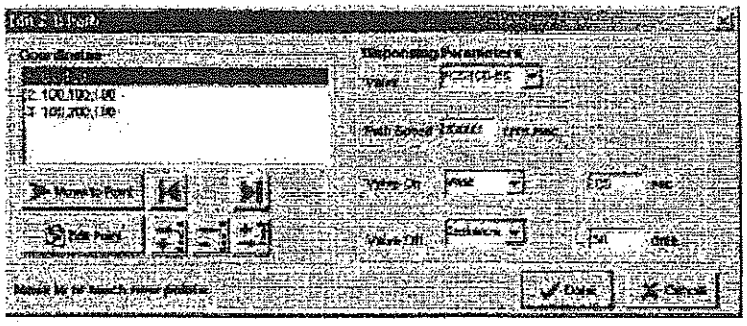
Programmed



Teach Screen



Edit Screen



This tool teaches 2D path segments. The Z axis does not alter its position during the path.

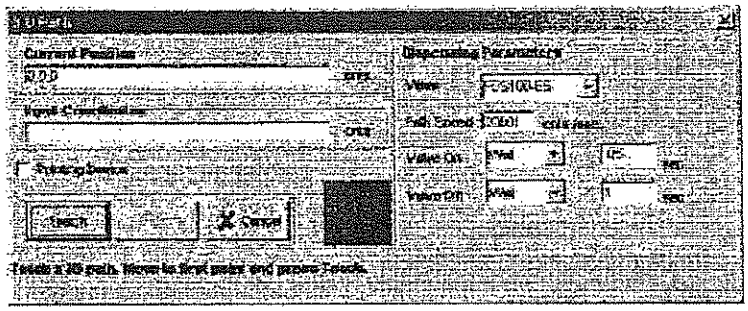
- **Current Position** – If there is communication established with the controller, the current position appears in the text box. Use the trackball on the Dispensing System to change the position.
- **Input Coordinates** – Manual entry of target position.
- **Dispensing Parameters** – Select appropriate parameters for the current dispense, including the active valve.
  - **Valve On Time** – The pause after turning the valve on but before starting the dispense path.
  - **Valve Off Time** – The pause after finishing the path and turning the valve off but before moving to the next point.
  - **Valve On Distance** – Distance the path traveled before turning the valve on.
  - **Valve Off Distance** – Distance the path traveled when turning the valve off, before the path finishes.
- **Teach** – Record the current point. Equivalent to the F2 key on the Dispensing System.
- **Done** – Add to the program.
- **Cancel** – Quit without altering the program.

NOTES: Playback is only allowed if the Dispensing System is currently in Manual/Jog/Teach mode.

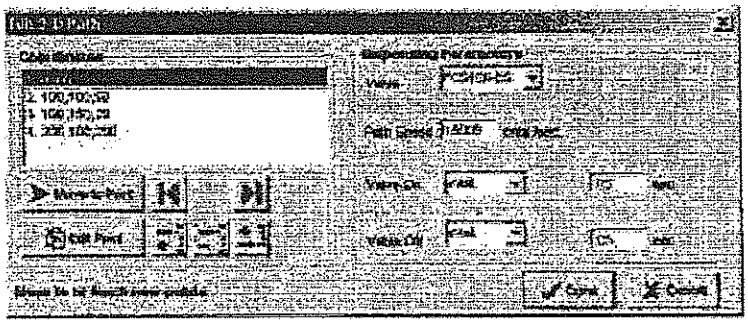
3D Path

Programmed

Teach Screen



Edit Screen



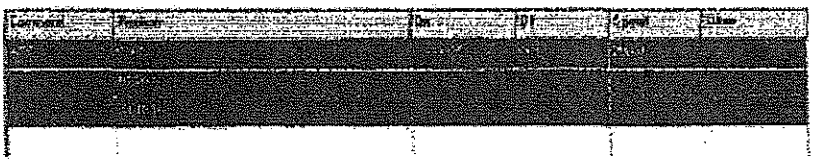
This tool teaches 3D path segments.

- **Current Position** – If there is communication established with the controller, the current position appears in the text box. Use the trackball on the Dispensing System to change the position.
- **Input Coordinates** – Manual entry of target position.
- **Dispensing Parameters** – Select appropriate parameters for the current dispense, including the active valve.
  - **Valve On Time** – The pause after turning the valve on but before starting the dispense path.
  - **Valve Off Time** – The pause after finishing the path and turning the valve off but before moving to the next point.
  - **Valve On Distance** – Distance the path traveled before turning the valve on.
  - **Valve Off Distance** – Distance the path traveled when turning the valve off, before the path finishes.
- **Teach** – Record the current point. Equivalent to the F2 key on the Dispensing System.
- **Done** – Add to the program.
- **Cancel** – Quit without altering the program.

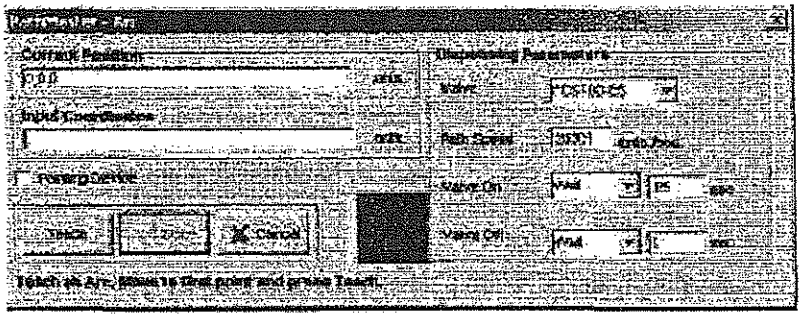
NOTES: Playback is only allowed if the Dispensing System is currently in Manual/Jog/Teach mode.

Arc

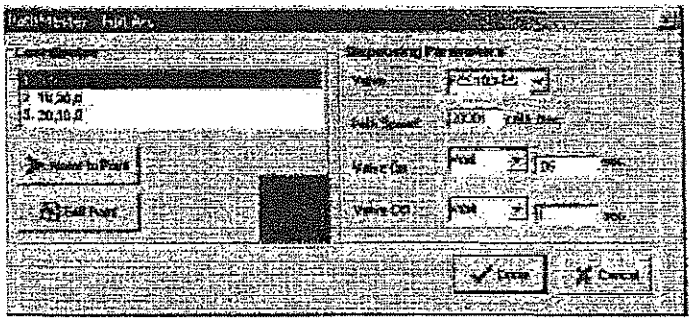
Programmed



Teach Screen



Edit Screen



This tool teaches an arc. The operator must select three (3) points on the arc length, including the beginning and end points, moving (clockwise or counter-clockwise) in the direction the axes must move. The Z axis does not alter its position during the path.

NOTE: When selecting points, space them evenly around the arc.

- **Current Position** – If there is communication established with the controller, the current position appears in the text box. Use the trackball on the Dispensing System to change the position.
- **Input Coordinates** – Manual entry of target position.
- **Dispensing Parameters** – Select appropriate parameters for the current dispense, including the active valve.
  - **Valve On Wait** – The pause after turning the valve on but before starting the dispense path.
  - **Valve Off Wait** – The pause after finishing the path and turning the valve off but before moving to the next point.
  - **Valve On Distance** – Distance the path traveled before turning the valve on.

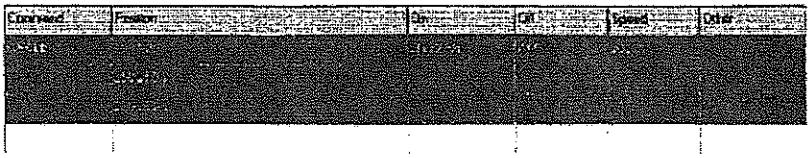
- Valve Off Distance – Distance the path traveled when turning the valve off, before the path finishes.

- Teach – Record current position. Equivalent to the F2 key on the Dispensing System.
- Done – Add to the program.
- Cancel – Quit without altering the program.

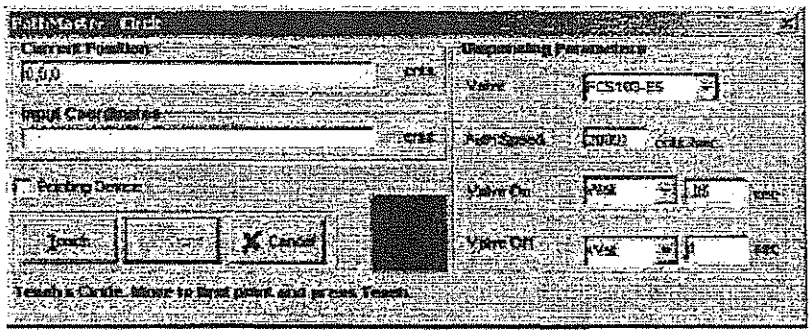
NOTES: Playback is only allowed if the Dispensing System is currently in Manual/Jog/Teach mode. Only three points can be plotted for the arc function.

Circle

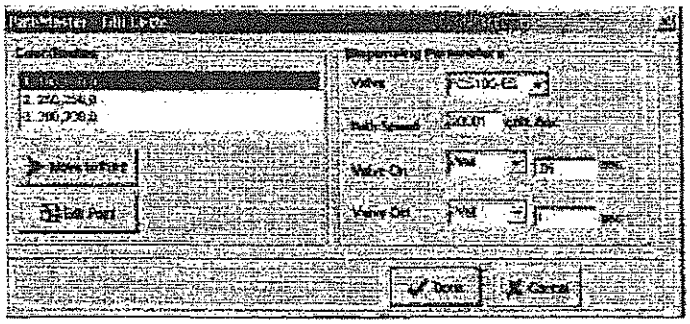
Programmed



Teach Screen



Edit Screen



This tool teaches a circle. The operator must select three (3) points on the circumference of the circle, including the start point, moving (clockwise or counter-clockwise) in the direction the axes must move. The Z axis does not alter its position during the path.

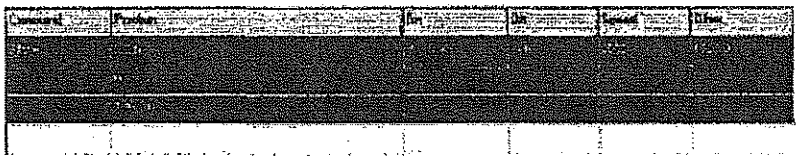
NOTES: When selecting points, space them evenly around the circle. Do not use the same point as the first and last point.

- **Current Position** – If there is communication established with the controller, the current position appears in the text box. Use the trackball on the Dispensing System to change the position.
- **Input Coordinates** – Manual entry of target position.
- **Dispensing Parameters** – Select appropriate parameters for the current dispense, including the active valve.
  - **Valve On Wait** – The pause after turning the valve on but before starting the dispense path.
  - **Valve Off Wait** – The pause after finishing the path and turning the valve off but before moving to the next point.
  - **Valve On Distance** – Distance the path traveled before turning the valve on.
  - **Valve Off Distance** – Distance the path traveled when turning the valve off, before the path finishes.
- **Teach** – Record current position. Equivalent to the F2 key on the Dispensing System.
- **Done** – Add to the program.
- **Cancel** – Quit without altering the program.

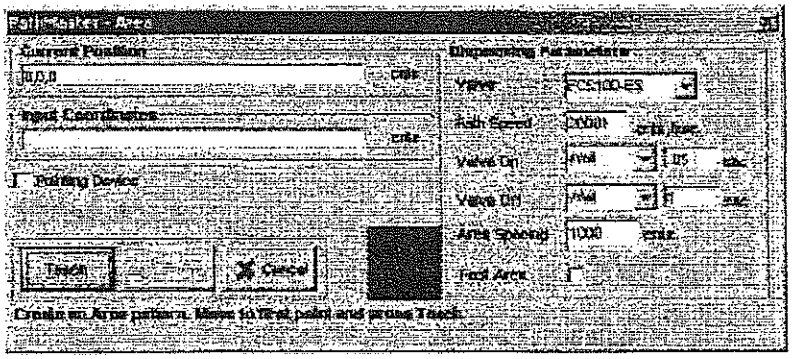
NOTES: Playback is only allowed if the Dispensing System is currently in Manual/Jog/Teach mode. Only three points can be plotted for the circle function.

Area

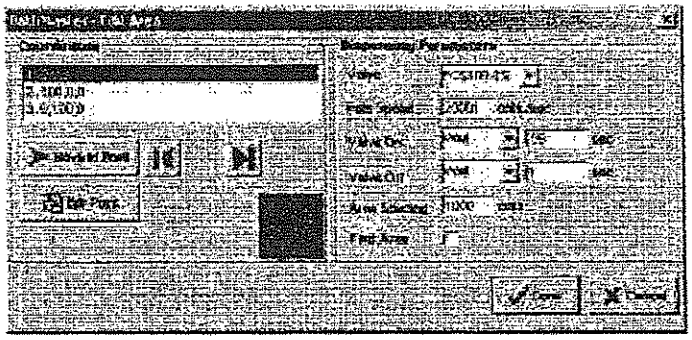
Programmed



Teach Screen



Edit Screen

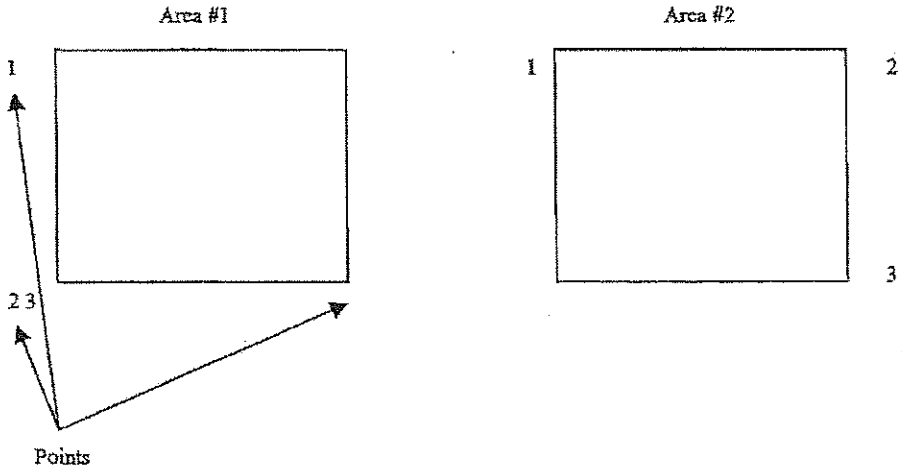


This tool teaches rectangular paths. The Z axis does not alter its position during the path.

- **Current Position** – If there is communication established with the controller, the current position appears in the text box. Use the trackball on the Dispensing System to change the position.
- **Input Coordinates** – Manual entry of target position.
- **Dispensing Parameters** – Select appropriate parameters for the current dispense, including the active valve.
  - **Valve On Wait** – The pause after turning the valve on but before starting the dispense path.
  - **Valve Off Wait** – The pause after finishing the path and turning the valve off but before moving to the next point.
  - **Valve On Distance** – Distance the path traveled before turning the valve on.
  - **Valve Off Distance** – Distance the path traveled when turning the valve off, before the path finishes.
  - **Area (or Path) Spacing** – Distance between runs.
- **Teach** – Record the current point. Equivalent to the F2 key on the Dispensing System. This button becomes inactive after the third point is taught.
- **Done** – Add to the program.
- **Cancel** – Quit without altering the program.

NOTES: Playback is only allowed if the Dispensing System is currently in Manual/Jog/Teach mode. Only three points are required for the Area tool.

How the Area tool works



By using only three points 'Area' path segments are calculated in the following manner:

Point 1 defines the start of the pattern. Point 2 defines the direction and length of the pattern. After the direction of the pattern is determined, the distance from point 1 to point 3 determines the width of the pattern. The width is divided by the 'Area Spacing' (or 'Path Spacing') parameter on the Area tool screen. The resulting value is the number of passes needed to fill the given area.

NOTE: For the above drawings, the X axis is vertical and the Y axis is horizontal.

Area #1

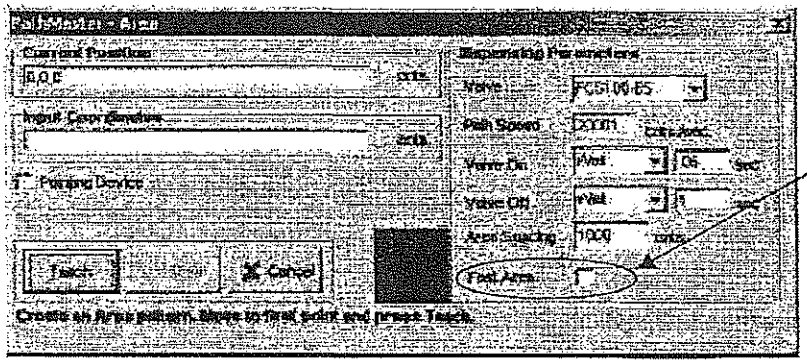
1) Point 1 defines the start.
2) Point 2 is along the X axis, so that is the direction of the path. The length of the path is the distance over the X axis. Therefore, the width is along the Y axis.
3) Point 3 defines the width. The width is the difference in Y between points 1 and 3. This is divided by the 'Area Spacing' (or 'Path Spacing') parameter resulting in the number of paths the machine needs to run to fill the given area.

Area #2

1) Point 1 defines the start.
2) Point 2 is along the Y axis, so that is the direction of the path. The length of the path is the distance over the Y axis. Therefore, the width is along the X axis.
3) Point 3 defines the width. The width is the difference in X between points 1 and 3. This is divided by the 'Area Spacing' (or 'Path Spacing') parameter resulting in the number of paths the machine needs to run to fill the given area.

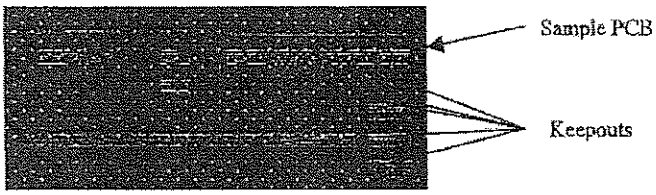
FastArea™

FastArea™ quickens the pace of the standard area by eliminating valve cycling between rows. This feature can have a dramatic impact on cycle time. To activate the FastArea™ feature; teach a standard area, and then check the FastArea™ check box.

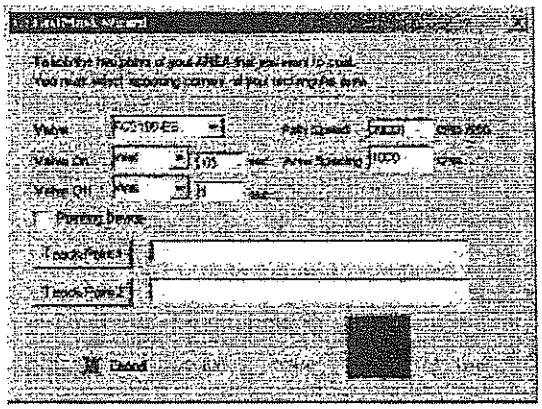


FastMask™

The FastMask™ tool will create an area to be coated as well as keep outs of within that area. There can be up to 99 keep out areas defined within the coating area.

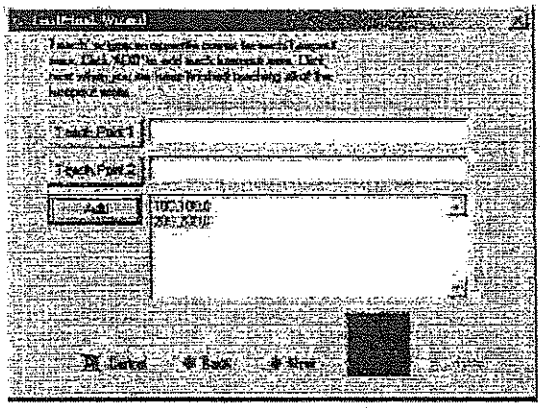


Once the Fastmask™ tool is selected, a wizard will open:



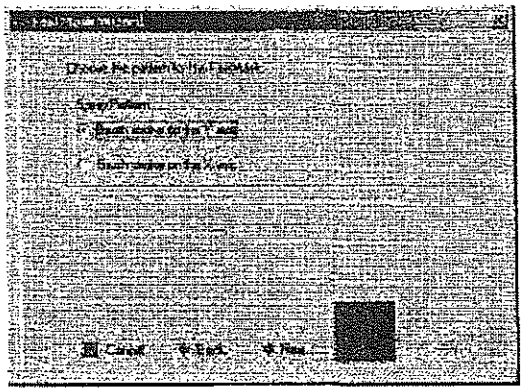
Select the appropriate valve parameters, then teach the opposing corners of the area to be coated, point 1 and point 2.

Click *Next* to continue:



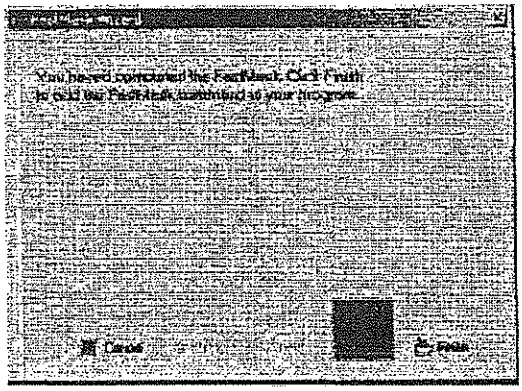
Teach the opposing corners of the first keep out area. Click *Add* to add the keep out to the FastMask™ list. Keep adding keep out areas (up to 99 keep outs) until all non-coat areas have been included in the FastMask™ list.

Click *Next* to continue:



Select the direction of the brush stroke. This is the direction the coating valve will travel when completing the FastMask™ pattern.

Click *Next* to continue:



The FastMask™ wizard is complete. Click *Finish*.

The FastMask™ pattern will always begin at the point taught closest to the origin of the gantry (the smallest coordinate in the pattern).

PolyLine

A polyline is a series of 2 dimensional lines, arcs, and circles. Polylines can be very useful in applications that require tight directional changes at higher speeds. Combining lines with arcs and circles will smooth the motion and create uniform corners and circles.

A polyline can be created using two different methods. Multiple path segments can be created using the conventional method and then converted to a poly line, or the polyline can be created using the PolyLine tool.

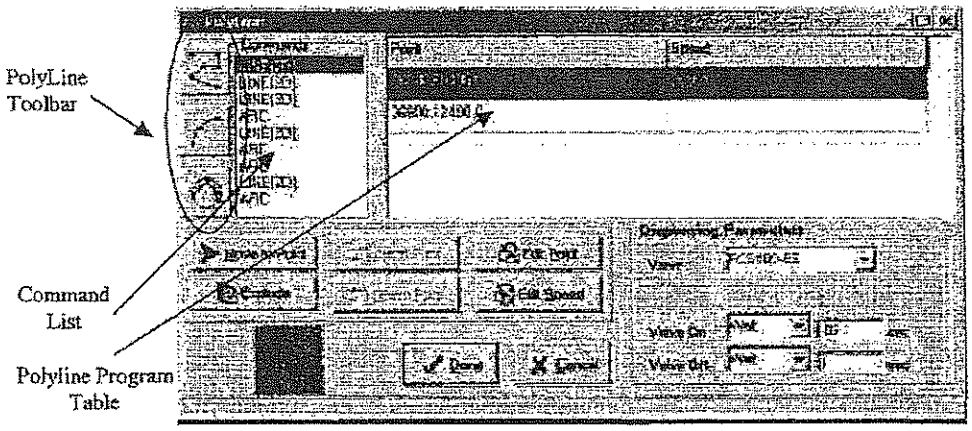
New Polyline

To create a new polyline, open the PolyLine tool, and select a programming tool from the polyline toolbar on the left. Teach the points required for the tool selected, and set the speed. As you complete each segment it is added to the command list on the left of the polyline program table. The polyline is limited to 511 points for all segments. Set the valve parameters.

NOTE: When teaching each segment in a polyline, the last point of the last segment will be used as the first point of the new segment. For example, a polyline arc (assuming it is not the first segment of the polyline) will only require teaching two points since the first point will be taken from the last point of the previous segment.

Select a segment in the command list and click the *Edit Point* button or the *Edit Speed* button to edit the points and speed for each segment. The polyline can also be exploded into individual path segments and modified on the main PathMaster® program table.

Once the polyline is complete click the *Done* button.



From Selected Line

To create a polyline from existing path segments, simply select the path segments to include in the polyline, access the Teach menu and select *PolyLine -> From Selected Lines*. If the endpoints of the path segments do not match up exactly, PathMaster® will ask you if you would like to match up the endpoints. If you choose not to match up the points the polyline will not be created. If you choose to match up the points, the polyline will match up the points using the best fit.

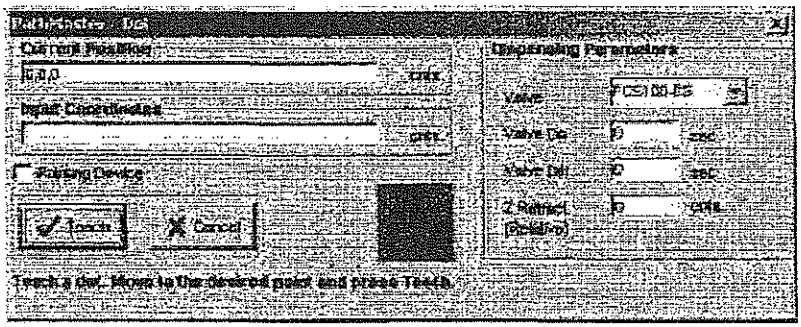
When creating a polyline from existing path segments, the valve parameters will be taken from the first path segment in the series. The speeds will be retained for each path segment.

WARNING: Be sure that all path segments selected for a polyline use the same valve as PathMaster® will assume that the valve used in the first segment is used throughout.

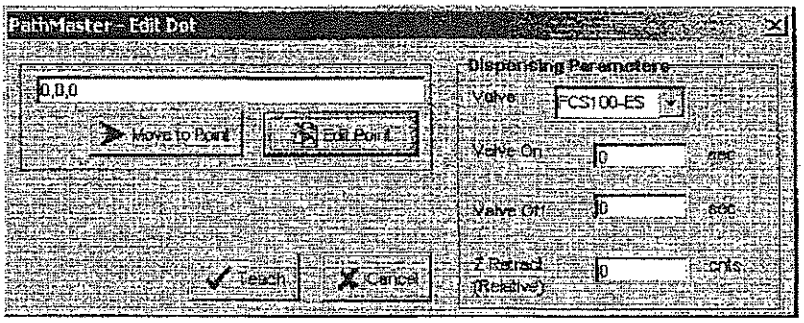
Dot

Programmed

Teach Screen



Edit Screen

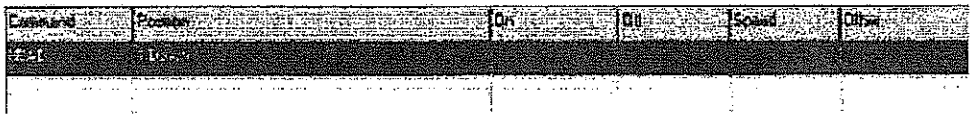


This function teaches a timed dispense.

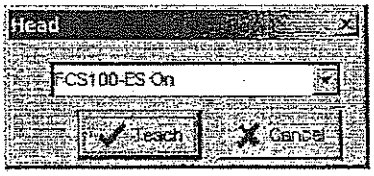
- **Current Position** – If there is communication established with the controller, the current position appears in the text box. Use the trackball on the Dispensing System to change the position.
- **Input Coordinates** – Manual entry of target position.
- **Dispensing Parameters** – Select appropriate parameters for the current dispense, including the active valve.
  - **Valve On Wait** – The length of time the valve remains on.
  - **Valve Off Wait** – The pause after turning the valve off but before moving to the next point.
  - **Z Retract (Relative)** – Distance to raise the Z axis after completing certain moves.
- **Teach** – Record current position and add to the program. Equivalent to the F2 key on the Dispensing System.
- **Cancel** – Quit without altering the program.

Head

Programmed



Entry Screen

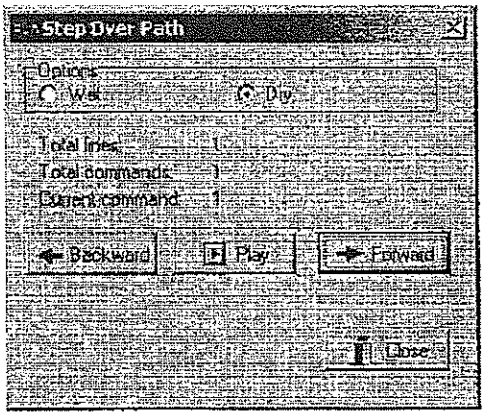


This function allows the operator to enter head (valve) commands into the edit window. The command is placed at the active field location. A head function only appears in the head tool once it has been configured in the machine parameter setup. Pneumatic positions (head up/down, rotary selection) are not automatically programmed by PathMaster® and there is no communication between the Dispensing System and PathMaster® with regard to the active valve or its pneumatic position. Therefore, it is the responsibility of the operator to select the appropriate valve within PathMaster® and to insert the necessary pneumatic commands into the program after a path has been completed. See Inserting Valve Commands into Programs on page 17 for further information about head function programming.

- **Teach** – Accept the current command and insert into the edit window.
- **Cancel** – Quit without generating code.

Step Over

The step over tool will allow you to step to the previous or next path segment and play it back wet or dry.

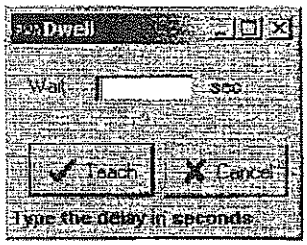


Quick Play

The quick play tool will play back the selected path segments in wet or dry mode. This is the equivalent of using the Run Selection option on the menu.

Dwell

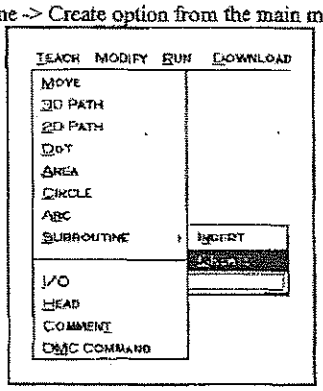
The Dwell tool will set a delay in program execution in between path segments.



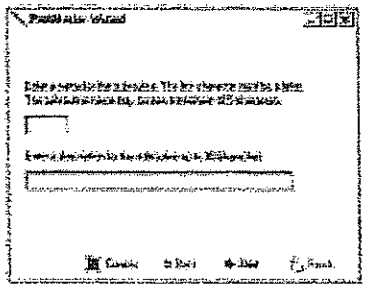
Subroutine

Creating

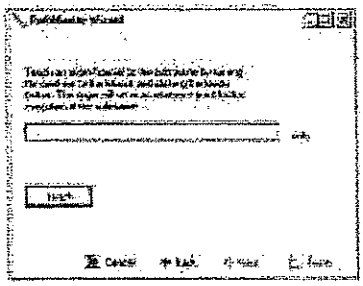
- *Highlight the commands* to be included in the subroutine.
- Select the Teach -> Subroutine -> Create option from the main menu.



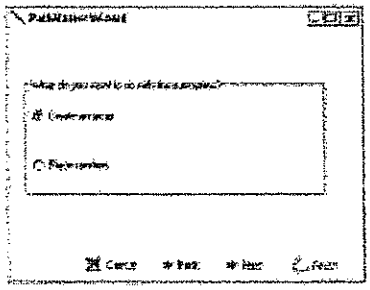
- This function allows the operator to use an existing command line element excluding DMC commands, in an array sequence or in random placement. You also have the option to insert existing subroutines in your program using 'Insert'.



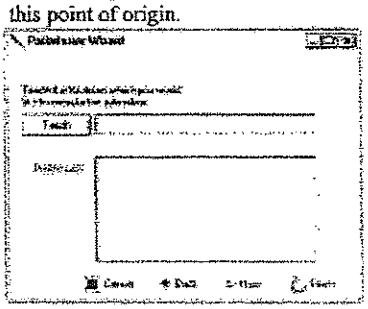
- Choose a n abbrev iated na me a nd bri ef description for the su broutine. The des cription serves to as sist th e operator when selecting from multiple saved subroutines.



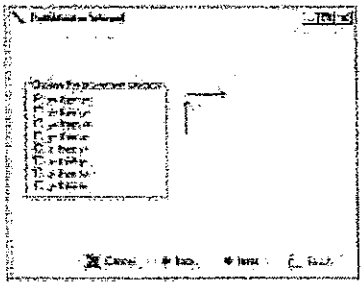
- Choose a ref erence poi nt on t he part t o group th e co mmand lin e s equences. Each execution of t he su broutine t o be array ed or ran dom p laced will b e referen ced from this point of origin.



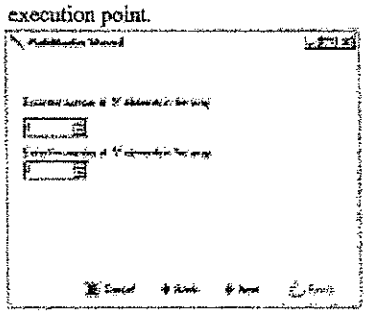
- Choose to create an arra y or s elect ran dom placement of the subroutine.



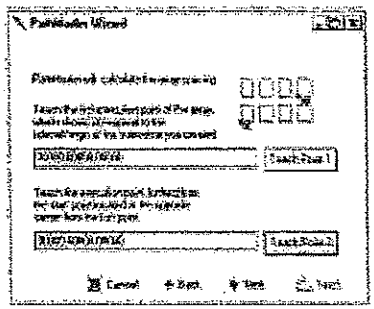
- This s creen corres ponds to ran dom program pl acement. B y sel ecting t he 'Teach' bu tion, P athMaster® utilizes t he current location o f th e e nd e ffector as an execution point.



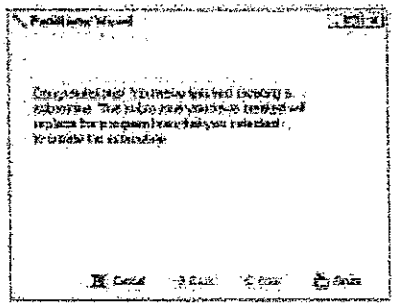
- Select t he directio n o f t he a rray. T he arro ws assist in determining the direction in relation to X,Y 0,0 origin of the current machine.



- Define t he number of el ements i n t he X direction and the Y direction.



- Assign the first and last points of execution. The coordinates to be entered are relative to the point of origin assigned in the previous steps. PathMaster® then calculates the distance for X and Y spacing.



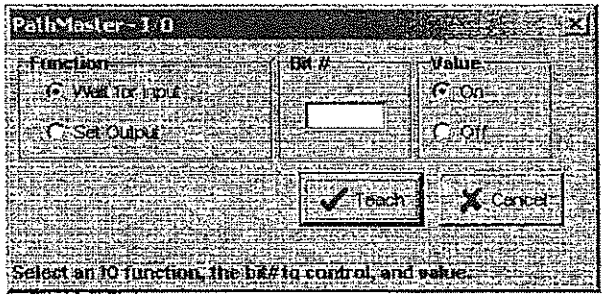
- This screen confirms the final step. By selecting finish, PathMaster® saves your created array or random placement and inserts it into your program. The chosen execution positions will appear in the main window.

Editing

- Save the current project.
- Select File -> Open -> Subroutine and choose the subroutine from the list.
- The stored subroutine code appears. Edit it like normal.
- Save the subroutine and reopen the current project.

I/O

Teach Screen

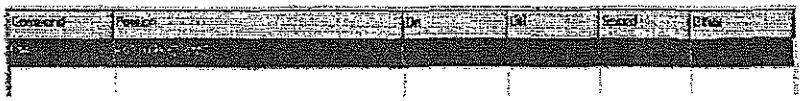


This function allows the operator to control outputs or wait for an input to be in a particular state. The I/O for this Dispensing System is located in the Machine Specific Information section of the Operating Guide. Operators who understand discrete I/O and its usage should only use this command.

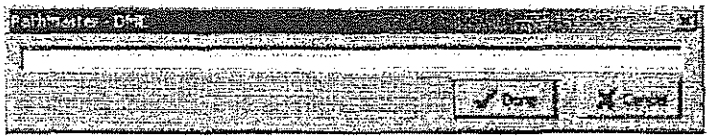
- **Function** – Select " Wait for input" to hold the program until an input is in the desired state. " Set Output" turns a discrete output on or off.
- **Bit #** – Location of the discrete I/O bit referenced.
- **Value** – The ON/OFF status desired.
- **Teach** – Accept the current command and add to the program.
- **Cancel** – Quit without altering the program.

DMC Command

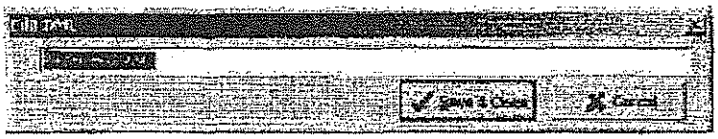
Programmed



Teach Screen



Edit Screen



This function allows the operator to enter DMC code into the program. Operators who thoroughly understand the DMC language and its usage should only use this.

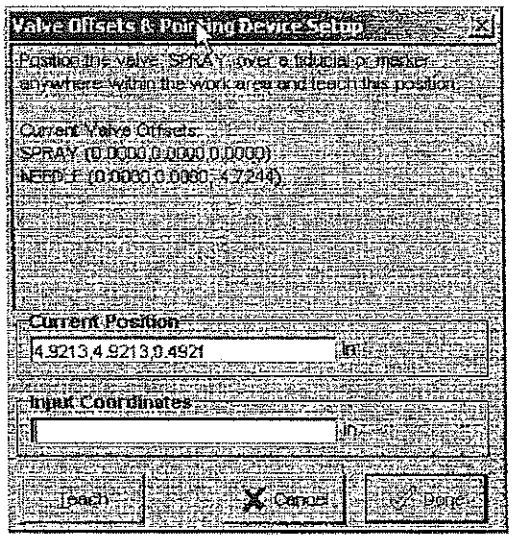
- **Done** – Accept the current code and add to the program.
- **Cancel** – Quit without altering the program.

Valve Offsets

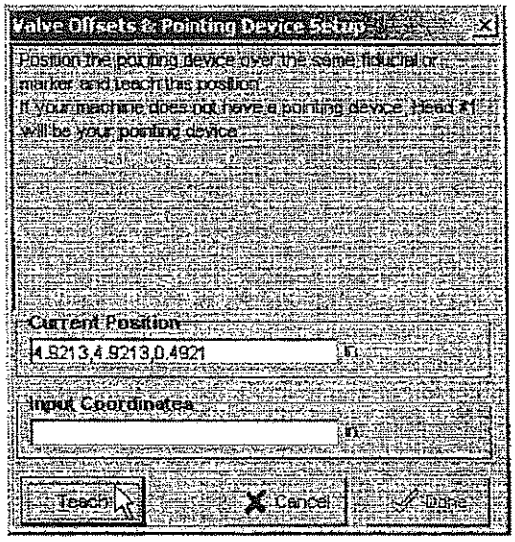
To use the offline programming feature or a pointing device with PathMaster® the valve offsets must be set correctly. A valve offset is the distance between a pointing devices and a valve. A pointing device could be another valve, a laser pointer, or a camera.

Open the Machine parameters window by selecting the Setup -> Machine Parameters option from the main menu. Click the *Valve Offsets* button. The valve offsets form will display. PathMaster® must measure the offset for each valve relative to the pointing device. To measure this distance the offset wizard will step through a series of instructional screens. The process will be to teach a valve at a fiducial point and then the pointing device. This process repeats for each valve until all offsets are programmed

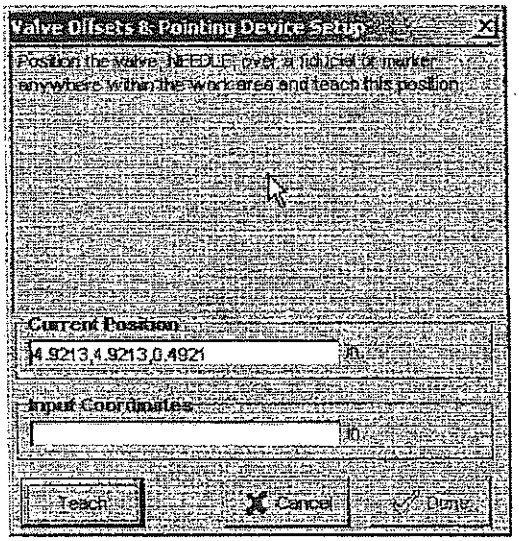
The process in our example will be for a two valve system. The first valve is called spray and the second valve is called needle. Follow the directions on the screen.



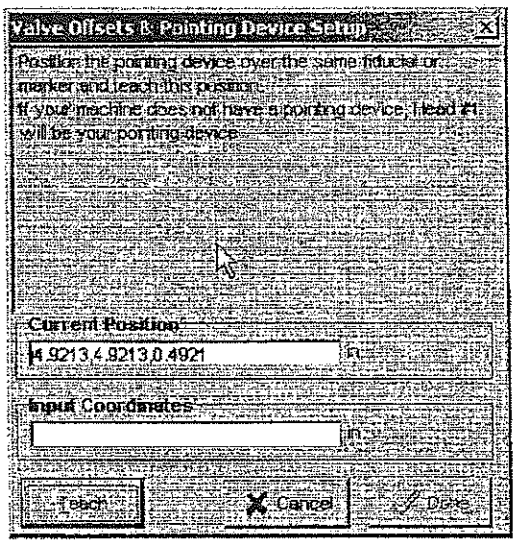
Move valve one (spray) over a fiducial which both the pointing device and valve one can reach. Click the *Teach* button when valve one is over the fiducial, making sure that the Z height is considered in the taught position.



Next move the pointing device over the fiducial. Click the *Teach* button. The distance between the pointing device and the fiducial has now been taught.

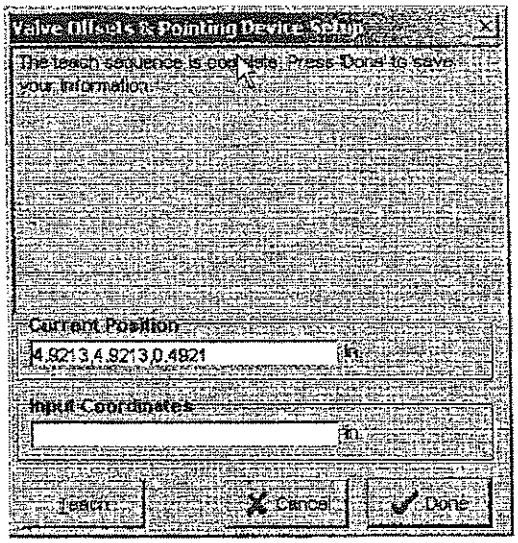


The next offset must be taught. Move valve two over the fiducial and click the *Teach* button.



Move the pointing device to the same location and press the *Teach* button.

The valve distances have now been taught.



The offsets have been taught. Click the *Done* button to save the valve offsets.

Click the *Save and Close* button to exit Machine Parameters.

Offline Programming (FastPath™)

Before using FastPath™, valve offsets must be configured. For more information on configuring valve offsets, refer to the Valve Offsets section of this manual.

Setting Up the Image

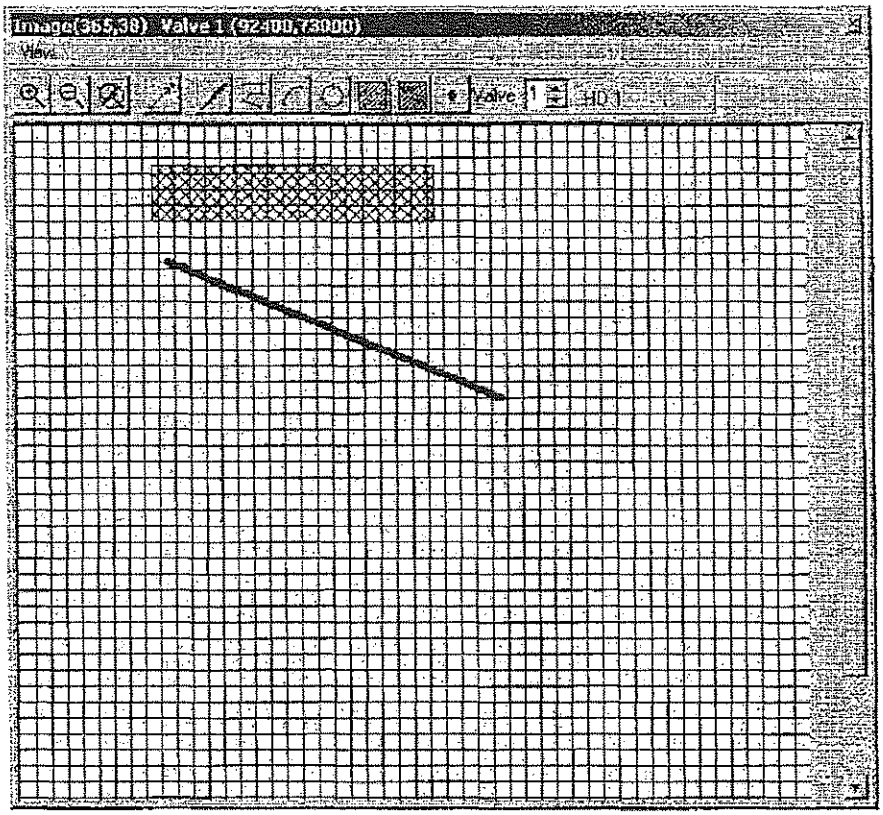
Open a new program. Click Edit->Program->Background Image. Choose the background image by clicking the *Change Image* button. If no image is selected the default image will be used. The default image is a 500 mm by 500 mm image with a workspace of the same size. The background image must be of a known size preferably the same size as your circuit board or entity to be dispensed upon. Type the *board width* (left to right) and the *board height* (top to bottom) of your board into the appropriate boxes using the corresponding units of measurement. Align your image to your workspace. The image may be aligned a number of ways. A good reference point could be the lower right of your image and the valve one coordinates for the intersection of the front rail and the board stop of your machine. Choose the *reference point type* and then find the machine coordinates for the same location. Type the valve one coordinates into the *robot reference point* edit boxes.

You have successfully setup your machine to use offline programming. Repeat these steps for each path program that will be taught using FastPath™.

Valve Selection

Valve selection selects the valve for each successive path segment for FastPath™. The valve selection is important because the valve offsets are taken into consideration to make the robot coat on the image where requested. If the valve offsets are not properly setup prior to using FastPath™, the path program will not run correctly. Select the appropriate valve prior to selecting a programming tool. The selected valve can be changed while using any programming tool as long as the new valve is selected prior to completing the path segment. For example: if user creates the first two coordinates of an area with valve one then selects valve 2 and completes the third point the path segment will be created using valve two.

Drawing a Program



You have setup you machine and program for FastPath™ and now it is time to draw your program on your image.

Press CNTRL+F (or click the FastPath™ icon on the programming toolbar) to open the FastPath™ window. The window opens. Press the *Zoom-In* and *Zoom-Out* buttons to get the image to a working size. Next choose which command you would like to use to generate a path segment. Each command will be inserted into your program above the highlighted portion of your path program. Each command will be added to the program table in succession until another object or path segment is selected. Once another object or path segment is selected, the insertion point for the next path segment will be above the highlighted or selected path segment in the program table. Press CNTRL+F to close the FastPath™ window and return to the normal PathMaster® editing window.

Most PathMaster® programming tools are available when using FastPath™. Each programming tool is used within FastPath™ similar to the way it would be used for online programming. Once a tool is selected, instead of pointing and teaching a position on the workcell, the FastPath™ points will be taught on the board image in the FastPath™ window using the corresponding valve.

Commands

NOTE: All programming tool procedures listed below are for FastPath™ only. Each path segment taught corresponds to the valve selected in the FastPath™ toolbar.

Move

Click the Move Icon on the FastPath™ toolbar. Next click the location within the image where you would like to move. The move form is displayed as normal. Make any modifications to the move location and click the *Done* button. The *Cancel* button will cancel the creation of the move command.

Head

The head tool adds an appropriate pneumatics head command to the path program.

2D Line

The 2D Line tool creates a line less than or equal to 511 points. Click the 2D Line button to select the tool. Next click all the points of the line on the image form. Each time a point is taught, the cursor will briefly become a crosshair indicating that the point was registered. When you are done creating all points, right click the mouse to complete the 2D Line. The 2 dimensional line will display on the board image with a spray or dispense width equal to the area spacing parameter of the selected valve. The 2D line can be edited graphically. See editing offline commands.

Arc

The Arc tool is created with two endpoints and a mid point. Click the Arc button to select the tool. Each time a point is taught, the cursor will briefly become a crosshair indicating that the point was registered. The arc will display on the board image as a complete circle. The playback of the arc will be the number of degrees between the points.

Circle

The Circle tool is similar to the Arc tool except that a full circle is created with three points. Click the Circle button to select the tool. Each time a point is taught, the cursor will briefly become a crosshair indicating that the point was registered. The circle will display on the board image. You may edit the circle by dragging any point of the circle to a new location. This will change the radius and location of the entire circle. Dragging the center point does nothing. It is displayed for reference.

Area

The Area tool is created using three points. Click the Area button to select the tool. Click any three points to generate an area command. The area command will behave as normal and the brush stroke will be from point one to point two. The area pattern will progress one brush stroke at a time in the direction from point two to point three.

FastMask™

The FastMask™ tool is used to create a coating area followed by keep out areas within the coating area. Click the FastMask™ button to select the tool. The first two point taught using FastMask™ define the opposing corners of the coating area. After the coating area is defined, a dialog box will appear asking the user to define the number of keep out areas within the coating area. A maximum of 99 keep out areas are allowed. Enter the number of keep out areas and click OK. Teach the opposing corners of each successive keep out area until the total number of keep out areas have been defined. The FastMask™ will display on the board image as a blue coating area with red keep outs.

Dot

The Dot tool creates a dot at the specified location on the board image. Click the *Dot* button to select the tool. The default dot *on* and *off* parameters for the selected valve are used for each dot.

Editing the commands

Objects taught on the board image may be modified once created. To modify or edit an object, click on the object to select it. Once the object is selected, its points can be dragged to a new location. An Area object can be resized by dragging its corners. The FastMask™ object can be resized in a similar manor. The 2D Line object can be modified by selecting the object. Once the object is selected, right click the object to reveal the edit menu (a popup menus will appear). Select Edit Path. The vertex points of the path will appear as squares. These points may be dragged around to change the 2D Line. Points may be added or deleted. Right click on a point and then left click on Delete to delete this point. Right click in between two points and click Add Point to add a point. When finished editing the object, click background image outside of the object to register your changes and update the object.

Password Protection

To prevent unauthorized or accidental changes to project files in PathMaster® and in the Dispensing System, password protection can be added to the download and save functions in PathMaster®.

Download Password

To add password protection to the download function in PathMaster®, select the Setup -> Password -> Set Download Password option from the main menu. If no password exists, you will be asked if you would like to create one. If a previous password exists, you must enter it correctly to continue. Next enter the new password, click *OK*. Then re-enter the password for verification and click *OK*. The PathMaster® Download Project and Download Main functions are now password protected. When either download is attempted, a password will be required to perform the download. If the password is entered incorrectly, the download is aborted.

Save Password

To add password protection to the save function in PathMaster®, select the Setup -> Passwords -> Set Save Password option from the main menu. If no password exists, you will be asked if you would like to create one. If a previous password exists, you must enter it correctly to continue. Next enter the new password, click *OK*. Then re-enter the password for verification and click *OK*. The PathMaster® save function is now password protected. When a Save or Save As function is attempted, a password will be required to perform the save. If the password is entered incorrectly, the save is aborted.

Changing Password

To change the save or download password, repeat the corresponding process listed above using the new password in place of the old.

Resetting Password

To reset the save or download password, repeat the corresponding process listed above, but do enter a new password in the new or confirm password fields.

Importing Files

The PathMaster® import function can import programs, projects, subroutines, and CAD files.

CAD Files

A 2-dimensional drawing generated in CAD can be imported into PathMaster® as a path program.

There are several steps required for a successful import. These include:

- Creation of the path drawing in CAD.
- Adding PathMaster® codes to the CAD drawing.
- Orienting the CAD drawing relative to the Dispensing System gantry.
- Exporting the CAD drawing to a *.dxf (AutoDesk Drawing Exchange Format)
- Importing the CAD drawing into PathMaster® using the CAD wizard.

Preparation of the CAD File

Below is the original drawing *(Figure 1)* and the required elements. *(Table 5) NOTE: The CAD X+ and CAD Y+ arrows are for reference only. These are not required.*

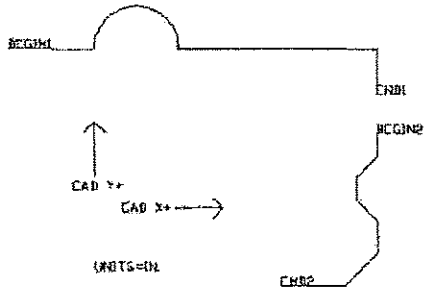


Figure 1: Original CAD Layout

Required Element		Description
BEGIN1, BEGIN2, etc.		Defines the start of the segment. The valve will turn ON at this point.
END1, END2, etc.		Defines the end of the segment. The valve will turn OFF at this point.
UNITS=IN. UNITS=MM. UNITS=CNTS.	*or* *or*	Defines the units used for creating the drawing. *Note: During the import process the path will be automatically converted to the units defined in PathMaster.*

Table 5 - Required CAD File Elements

After all necessary elements have been included in the drawing it must be MIRRORED on the Y axis. (Figure 2) ***NOTE: In AutoCAD be sure to "Delete Old Objects" when prompted".***

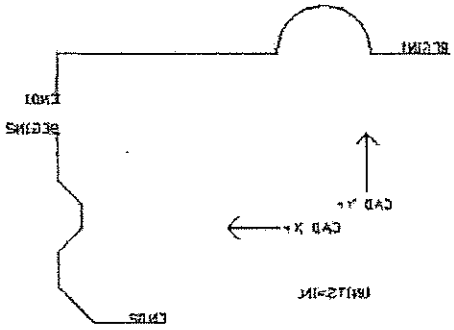


Figure 2: CAD drawing Mirrored on Y axis

The drawing must be Rotated Clockwise 90 degrees (-90deg for standard AutoCAD Setup). (Figure 3)

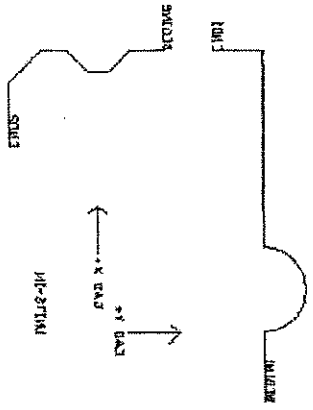


Figure 3: CAD Drawing rotated 90deg.

The final step is to export the file to a **.dxf.*

In AutoCAD:

- Click the File->Export menu.
- When the Export Data window comes up, select Save As Type AutoCAD R12/LT2DXF.
- Under the Options button ensure that the Export Format is ASCII.
- Give the file a name and save it.

Importing the file into PathMaster

The path will be imported to a new program.

Click on File ->Import ->Program ->DXF File. Te following screen appears. (Figure 4)

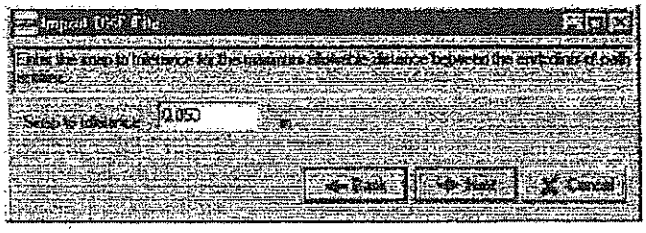


Figure 4: PathMaster import screen #1

The snap to tolerance must be set properly to allow the import process to recognize the proper associations between drawing segments in the CAD file. A minimum of 0.015" is recommended. ***NOTE: This does not affect the accuracy of the path. It only allows for proper translation of the drawing entities.***

Choose the method of importation (Figure 5). Paths from Begin to End will import the file as drawn, with proper segment ordering (BEGIN1,END1, etc.) observed. *All Entities* ignores commands for order of operations, but is useful for large files with many paths, such as placement of dots, where each segment may not be *numbered.*

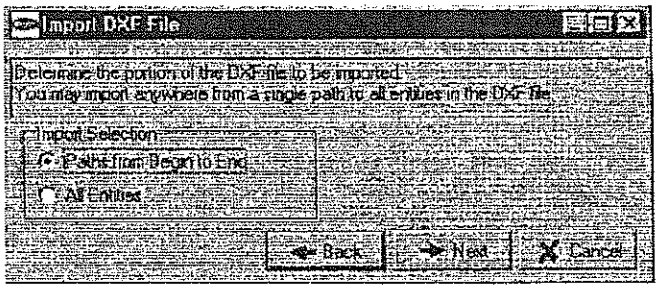


Figure 5: PathMaster import screen #2

Choose the location of the starting point. (Figure 6) This can be taught via trackball from the machine OIT or a typed location.

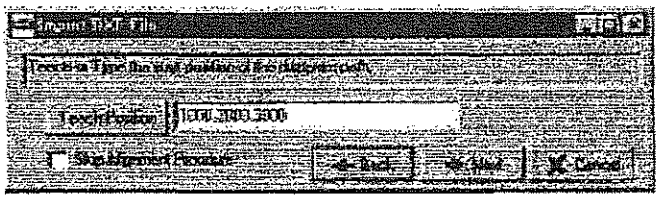


Figure 6: PathMaster import screen #3

Select the file to import. *(Figure 7)*

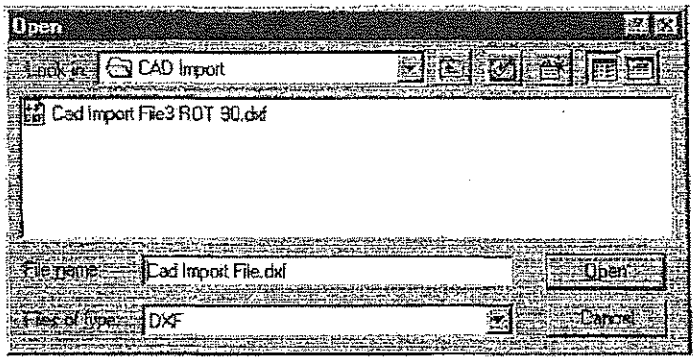


Figure 7: PathMaster import screen #4

After a successful import the path will be displayed in a path preview window.

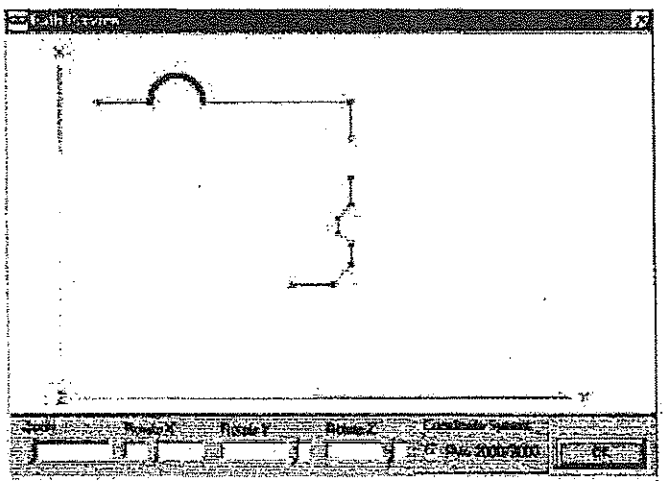


Figure 8: PathMaster import screen #4

The file will be imported as individual paths. (Line, Arc, etc.) The paths are ready for playback or may be converted to a polyline.

PathMaster® 1.5 & Pre 1.5 Projects

To import a PathMaster® 1.5 or pre 1.5 project, select the File -> Import -> Project -> PathMaster 1.5 or Pre PathMaster 1.5 option from the main menu. When the file dialog box opens, select the location and the file name of the project to import. Click *Open*.

NOTE: You may need to change the file filter (type) to *.txt, or *.dmc to see the project file in the dialog box.

Text File

A properly format tab delimited text file can be imported into PathMaster® as a path program. Select the File -> Import -> Program -> Text File option from the main menu. When the file dialog box opens, select the location and the file name of the project to import. Click *Open*. A text file program is typically a file that was exported as a text file from PathMaster®

NOTE: You may need to change the file fitler (type) to *.txt to see the project file in the dialog box.

DMC File

A properly format DMC file can be imported into PathMaster® as a path program. Select the File -> Import -> Program -> DMC File option from the main menu. When the file dialog box opens, select the location and the file name of the project to import. Click *Open*.

NOTE: You may need to change the file filter (type) to *.dmc to see the project file in the dialog box.

Subroutine

A properly formated subroutine can be imported into PathMaster® using the import subroutine option. Select the File -> Import -> Subrotuine -> Text File option from the main PathMaster® menu or the File -> Import subroutine option from the subroutine edit window menu. Select the location and name of the subroutine and click the *Open* button.

NOTE: You may need to change the file filter (type) to *.txt to see the project file in the dialog box.

Once the import is complete, the subroutine edit window will be open.

Exporting Files

The PathMaster® export function can export programs, projects and subroutines.

Text File

To export a program to a tab delimited text file, select the File -> Export -> Program -> Text File option from the main menu. When the dialog box appears, select a location and file name for the program, and click *Save*.

DMC File

To export a project to a DMC or DMC compressed file, select the File -> Export -> Project -> DMC File or Compressed DMC File from the main menu. When the dialog box appears, select a location and file name for the program, and click *Save*.

Subroutine

To export a PathMaster® subroutine to a tab delimited text file, select the File -> Export -> Subroutine -> Text File option from the main PathMaster® menu or the File -> Export Subroutine option from the subroutine edit window menu. Select the location and name of the subroutine and click the *Save* button.

Utilities

PathMaster® has a variety of utilities to help with debugging, the Dispensing System, as well as path programs. These utilities can be found under the Utilities menu.

View FastPath

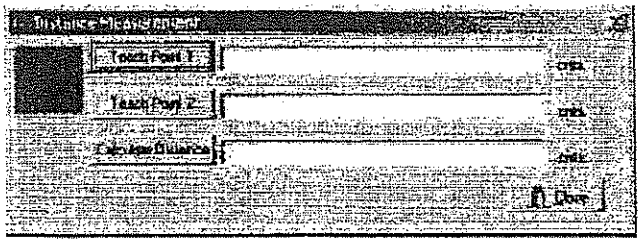
To open the FastPath™ window for offline programming, select the Utilities -> View FastPath option from the main menu.

NOTE: The FastPath™ window can also be accessed using the FastPath™ button on the programming toolbar.

Measure Distance

The distance measurement tool is used to measure the distance between two points using current measurement units. To open the tool, click the Utilities -> Measure Distance option from the main menu.

To measure distance, move the head to the first point, click *Teach Point 1*. Move the head to the second point, click *Teach Point 2*. Click the *Calculate Distance* button. The distance will be calculated and display.

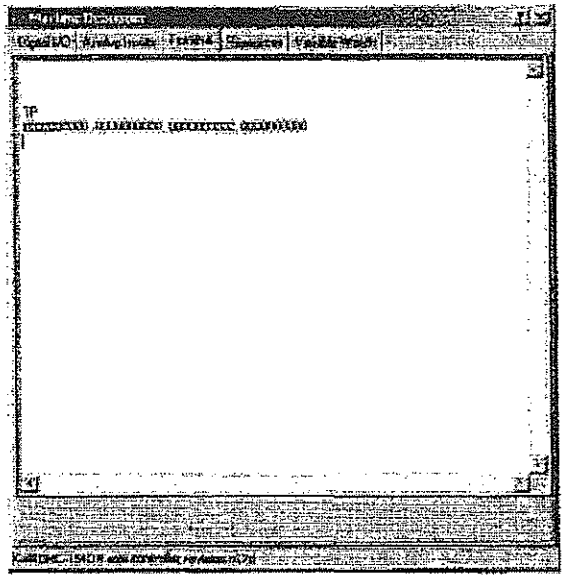


Machine Debugger

The machine debugger is an array of tools to aid in the debugging of the Dispensing System. To access one of the debugging tools, select Utilities -> Machine Debugger from the main menu. When the machine debugger opens, select the tab for the tool to be used.

Terminal

The terminal lets the operator send commands directly to the controller. To send a command to the controller, ensure the keyboard caps lock is on, type the command in the terminal window, and press the *Enter* key. A response from the controller will display under the command that was issued. If the controller does not understand what it received, it will respond with a "?".



Some guidelines for working directly with the controller are listed below. For more information on using the terminal or working directly with controller, consult the online controller manual.

DMC Programming Basics

- All commands must be given in uppercase letters.
- Positions are given in counts. In most cases there are 5080 counts per inch, 200 counts per millimeter.
- No line of code may contain more than 80 characters.
- A semicolon (;) is used as a carriage return. This allows for multiple commands on the same line and can be used to save space in the program.

Labels

Sections of a program (subroutines) are defined by labels. Labels start with the pound (#) sign followed by a maximum of seven characters. The first character must be a letter; after that, numbers are permitted. Spaces are never permitted. PathMaster® generates its own labels for programs. These labels do not appear in the edit window, so the operator cannot alter them.

No duplicate labels are allowed anywhere in memory. The *Main* program and PathMaster® are written without any duplicate labels. However, it may be necessary for the operator to insert special labels into programs. If any duplicate labels occur anywhere within a PathMaster® project, the operator must find the duplication and fix it. These errors most commonly occur when a section of code has been copied and pasted elsewhere. There can be no duplicates anywhere within a project, which includes all 30 programs in that project.

Labels must appear at the start of a line. An operator manually entering code must ensure that no labels exist in the middle of a line. This generates an error when running the program.

Important Commands

The DMC programming language contains over 135 commands. For programming the Dispensing System the majority of these commands are not used and even fewer are used for creating dispense paths. The following commands are the most important for an advanced operator to know. A complete list of commands can be found in the separate DMC-1500 manual that accompanied the machine. Any reference to manually changing or querying in the examples below requires the use of the terminal option in PathMaster® to communicate directly with the controller.

Table 6 – Important DMC Commands

Cmd	Description	Example	Tips
AC	Acceleration for independent moves are in counts per second².	AC*=100000 (sets all axes), ACX=100000 (only sets the X axis acceleration)	Make sure the value of the acceleration is high enough to get the motion to speed within a reasonable amount of time.
AM	After move. This command holds the program until the movement on the specified axes is completed.	AM (wait for all axes to finish its motion), AMS (wait for coordinate sequence to finish motion).	The AM command tests for profile completion. Use the AM command to separate multiple movements.
AV	After vector distance. This command holds the program until a specified distance has been traveled during a coordinated move. The units are in counts.	AV1000 (wait until the axes have moved 1000 counts).	The AV command resets to zero after every use. It can be calculated by summing the distances between each point on the coordinated move.
BG	Begin. BG starts a motion on an axis or a sequence.	BGX (begin motion on the X axis), BGS (begin motion sequence), BG (begin motion on all axes).	A second BG command cannot be given until the first BG motion is finished. The AM command can be used to hold the program until the first motion is complete. It is best to specify the exact axes to put into motion. The BG command by itself starts ALL the axes according to the last specified motions.
BL	Reverse Software Limit		
CB	Clear bit. Clears a bit on the output port.	CB40 (clears the bit for the buzzer).	Clearing a bit in DMC terminology turns the bit on. The opposite of CB is SB (set bit). A complete list of the outputs can be found in the Machine Specific Information section of the Operating Guide.
CR	Circle. Specifies a radius, a starting angle and the angle to be traversed. Movement is counterclockwise, by default, in the Cartesian coordinate system. This is either clockwise or counterclockwise, as viewed from the front of the machine, depending upon the mechanical setup of the	CR 5000,90,180 (arc with length of 5000 counts, starting at 90° and doing a half circle (180°)).	The circle command is a coordinated two dimensional move. The structure is the same as all other coordinated moves, using the VM, VP and VE commands (see Examples of Dispense Programs on page 44).A start angle of 0° produces a circle, relative to the start point, entirely negative in the X direction and half positive, half negative in the Y. Starting at 180° yields an entirely

	machine. Specifying a negative traverse angle yields clockwise motion in the Cartesian coordinate system.		positive X circle and a half positive, half negative Y. Similarly, 90° is an entirely negative Y circle, 180° entirely positive Y, with both having X half positive, half negative.
CS	Clear Sequence	Clears Memory of prior coordinated sequences.	
DC	Deceleration for independent moves. The units are in counts per second².	DC*=100000 (sets all axes), DCX=100000 (only sets the X axis deceleration), DC 10000,30000,40000 (sets X, Y and Z Decelerations separately).	The higher the deceleration, the faster an axis stops its move.
DE	Dual (Auxiliary) Encoder Position		
DL	Download. This transfers a text file from the computer to the controller.	DL (then select a text file to download).	Use the HX (halt execution) command before using DL. Damage may result otherwise.
EN	End. This terminates a subroutine, program thread or program.	EN	The Dispensing System also has a subroutine used for a conditional end. The command JP#NOOP operates the same as the EN command.
FL Fo	rward Software Limit		
HX	Halt execution. Halts the execution of the program or any of its threads.	HX1 (halt thread 1), HX (halt the entire program).	Always use the HX command before executing a DL command.
JG Jog			
JP	Jump to a program location. Locations are marked by labels. This command can be used in a conditional statement and the jump occurs if the conditional is true.	JP#NOOP (jump to location #NOOP), JP#NOOP,COUNT>10 (jump to location #NOOP if the value of COUNT exceeds 10).	It is important not to confuse JP with JS. Using a JP when a JS is required results in the thread being halted once the EN command is reached.
JS	Jump to subroutine. Subroutines are marked by labels.	JS#H1UP (jump to subroutine #H1UP).	It is important not to confuse JS with JP. Using a JS when a JP is required can result in "nesting" the program continuously until a nesting error occurs. Subroutines can only be nested 16 deep.
LI	Linear Interpolation Distance		
LM	Linear Interpolation Mode		
LS	List. The operator can list a single line or multiple lines of the program in a terminal screen.	LS 300,0 (show line 300), LS 250,270 (show lines 250 to 270), LS (show all lines in memory).	If a runtime error occurs, use the LS command in the terminal screen to check the line containing the error.
MG	Message. This command sends data out the bus. It can also be used by the operator to query the controller for information.	MG "Path Complete" (displays the message "Path Complete" on the terminal screen), MG@IN[60] (displays the value of input 60, where 0 is on and 1 is off).	Do not put message commands in programs! If there are message commands, and there is no computer attached to the Dispensing System, the controller halts once the output

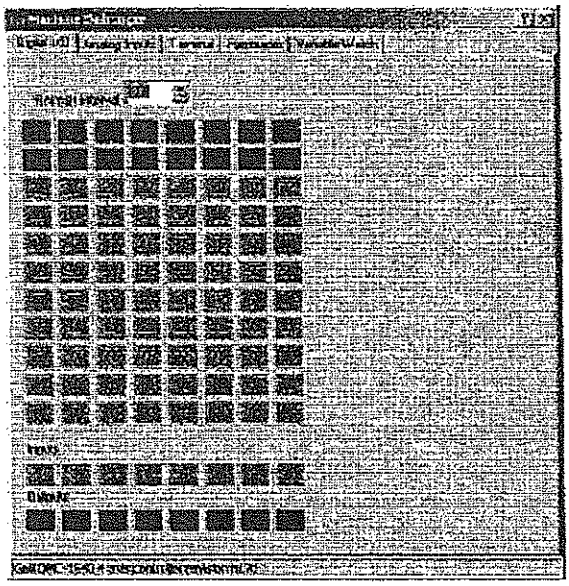
			buffer is full.
MO	Motor off. Shuts off motor control.	MO (turn all motors off), MOX (turn off only the X axis motor).	MO shuts off the motor(s).The motors are reactivated with the SH (servo here) command.
MR	Reverse Motion to Position		
MT M	otor Type		
NO	No operation. This command performs no action and is used to comment a program.	NO!!! PROGRAM 1!!!! (description for program).	A semicolon (;) terminates the NO command. Any statements following a semicolon are executed.
PA	Position absolute. This sets the destination of a move, referenced to the origin. The units are in counts.	PA 10000,10000,1000 (commanded position for X, Y and Z axes), PAX=10000 (commanded position of X axis).	It is best to limit the use of the PA command to designating the start of a dispense path. Overuse of the PA command complicates program editing.
PF P	osition Format		
PR	Position relative. This sets the incremental position of the next move, referenced to the current position. The units are in counts.	PR 10000,10000,1000 (commanded change in position for X, Y and Z axes), PRX=10000 (commanded change in position of X axis).	Be careful not to confuse PA with PR. The PR command begins its move from the current position, without reference to the origin.
RS	Reset. Resets the controller to its power on state. All the information in the controller's RAM is erased.	RS	If PathMaster™ fails to download a file properly, the program may be halted in the controller. Executing an RS command from the terminal screen restarts the program.
SB	Set bit. Sets a bit on the output port.	SB40 (sets the bit for the buzzer).	Setting a bit in DMC terminology turns the bit off. The opposite of SB is CB (clear bit).A complete list of the outputs can be found in the Machine Specific Information section of the Operating Guide.
SC S	top Code		
SH	Servo here. The controller uses the current position as the command position and enables motor control.	SH (activate all motors), SHZ (activate only the Z motor).	The opposite of SH is MO (motor off).SH resets all position errors to zero.
SP	Speed. Sets the speed for independent moves. Units are in counts per second.	SP*=100000 (sets all axes), SPX=100000 (only sets the X axis speed), SP 10000,30000,40000 (sets X, Y and Z speeds separately).	Make sure the value of the acceleration is high enough to get the motion to speed within a reasonable amount of time.
ST	Stop. Halts motion on the specified axes. If no axes are specified, it halts program execution.	STX (stop motion on the X axis), ST (stop all motion and halt the program).	Use the AM command after the ST command to wait for motion to be stopped.
TB			

TC	Tell error code. Displays the number and a text description for a command error.	TC1	
TD	Tell Dual Encoder		
TE	Tell error. This returns the current position error of the motors. Units are in counts.	TE	Use this command in the terminal screen if a motor appears to be working incorrectly. The Dispensing System is programmed to disregard errors of less than 1000 counts.
TP	Tell Position. Returns the current position of the motors.	TP (All axes). TPX (X axis only).	Use in the terminal screen to verify the current location of the motors. In addition, the Manual/Jog/Teach mode of the Dispensing System has a push button that accomplishes the same task.
VA	Acceleration for coordinated moves. The units are in counts per second².	VA 100000.	Make sure the value of the acceleration is high enough to get the motion to speed within a reasonable amount of time.
VD	Deceleration for coordinated moves. The units are in counts per second².	VA 100000.	Make sure the value of the acceleration is high enough to get the motion to speed within a reasonable amount of time.
VE	Vector Sequence End		
VP	Vecto r Position		
VS	Vector Speed. Sets the speed for coordinated moves. Units are in counts per second.	VS 100000. Query the controller with the command MG_VS.	Make sure the value of the acceleration is high enough to get the motion to speed within a reasonable amount of time.
WT	Wait. Holds program execution for specified time.	WT500	Use the WT command whenever the program needs to pause, particularly if another action needs time for completion.

PVA\

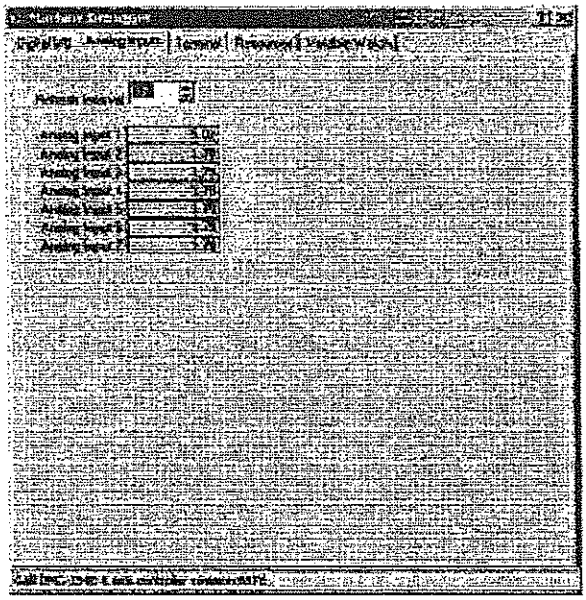
Digital I/O

The digital I/O tool allows for toggling of most digital IO points on the controller. Find the button for the I/O point you wish to toggle, and click it. The button will change colors when the I/O point changes state. The refresh interval is the frequency of the tool display refresh in milliseconds.



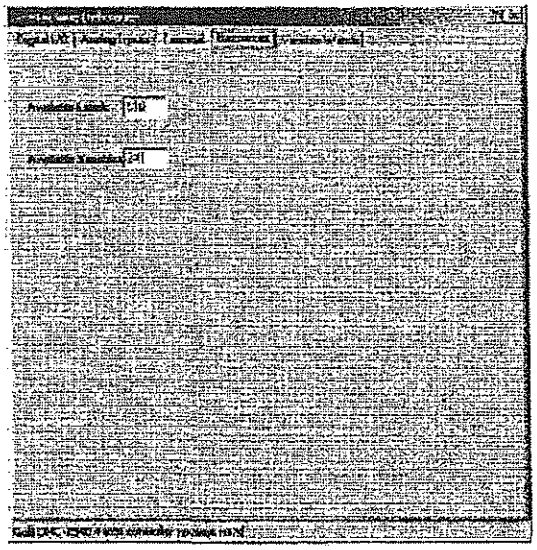
Analog Input

The analog input tool will monitor the value of analog input feedback. The refresh interval is the frequency of the tool display refresh in milliseconds.



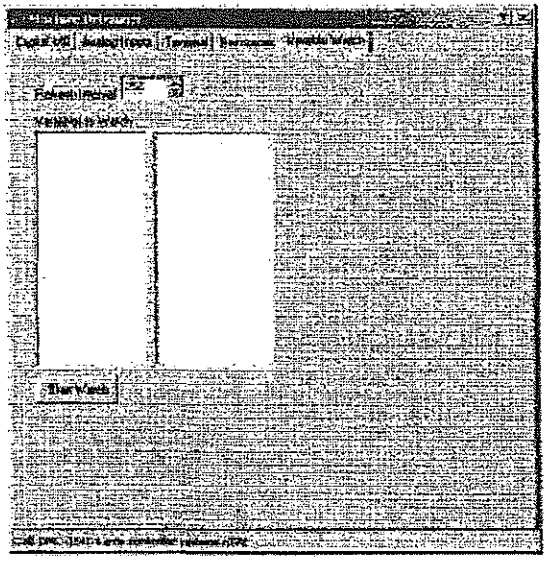
Resources

The resources tool allows monitoring of controller resources such as available program labels, and program variables. The type of resources displayed on this form will vary depending on the model of controller being used.



Variable Watch

The variable watch tool will monitor a list of program variables entered by the user. Type a valid program variable name into the watch list on the left, click *Start Watch* and the value of the variable will be displayed on the right. Multiple variables can be monitored simultaneously. The refresh interval is the frequency of the tool display refresh in milliseconds.

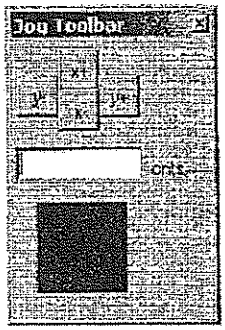


Refresh Communication

If PathMaster® loses communication with the Dispensing System, select the Utilities -> *Refresh Communications* option from the main menu. If communication is not reestablished, check cables and communication setting.

Jog Toolbar

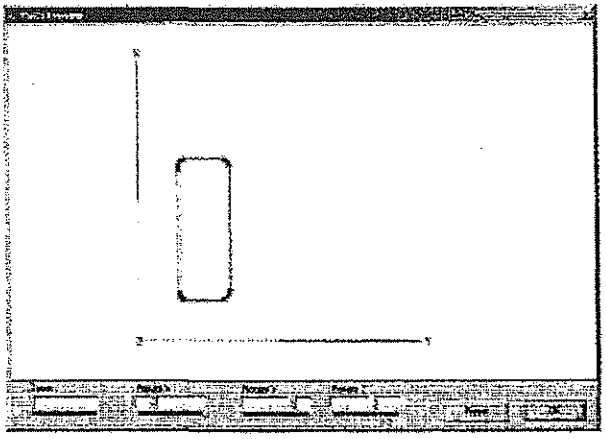
The jog tools bar can be used to jog the X or Y axis a specified distance. Select the Utilites -> Jog Toolbar option from the main menu. Enter the distance to jog, and click the button indicating the axis and direction to move.



NOTE: The jog toolbar also has a TracPad™ that can be activated to jog the head. Refer to the TracMouse™ section of this manual for more information on using the TracPad™.

Path Preview

The path preview will give a graphic representation of the path program or segments. Highlight all path segments to be displayed in the preview. Select the Utilites -> Path Preview option from the main menu. The path preview window will display:



Right click the path preview window to reveal a zoom, pan, rotate, coordinate info menu. Click the *Reset* button to return the preview to its default display.

Show Code

The show code option will display the compiled machine code for the selected segments. Highlight the path segments; select the Utilities -> Show Code option from the main menu. A form will open displaying the machine code fro the selected segments. The code can be saved to a text file, or printed to a hard copy.

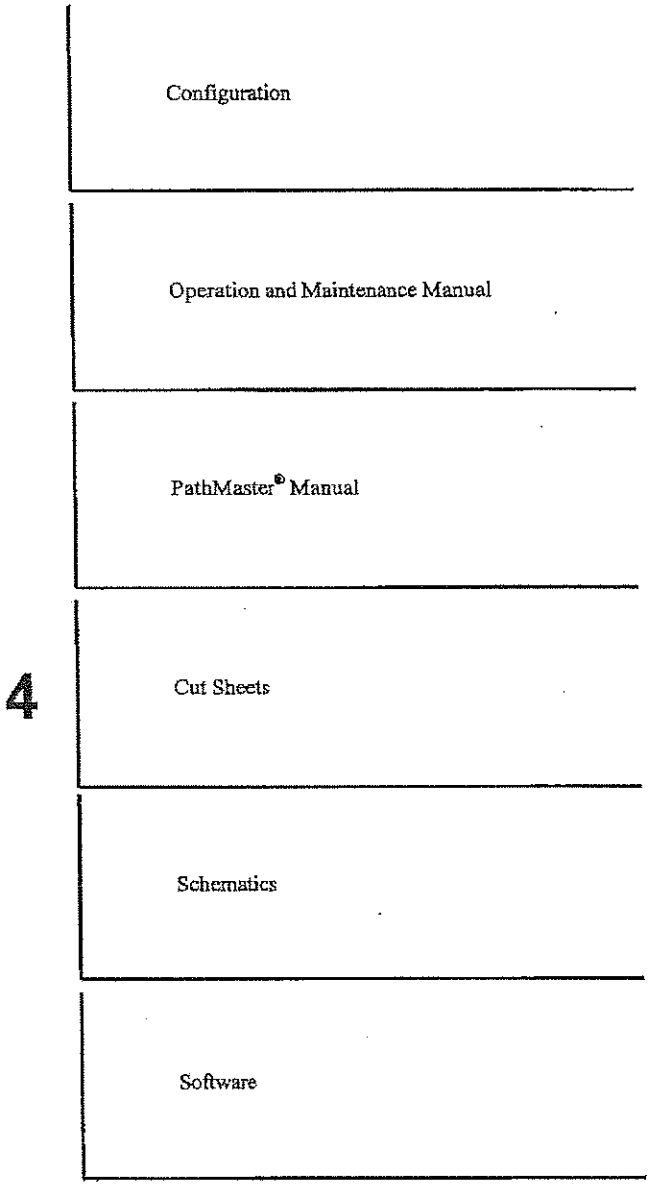
DMC Error Codes

Table 7 – DMC Error Codes

#	*Description*
1	Un recognized command
2	Command only valid from program
3	Command not valid in program
4	Operan d error
5	Input buffer full
6	Number out of range
7	Command not valid while running
8	Command not valid while not running
9	Variable error
10	Empty program line or undefined label
11	Invalid label or line number
12	Subroutine more than 8 deep
13	JG only valid when running in jog mode
14	EEPROM check sum error
15	EEPROM checkwrite error
16	IP incorrect sign during position move or IP given during forced deceleration
17	ED, BN and DL not valid while program running
18	Command not valid when contouring
19	Application strand already executing
20	Begin not valid with motor off
21	Begin not valid while running
22	Begin not possible due to Limit Switch
24	Begin not valid because no sequence defined
25	Variable not given in IN command
28	S operand not valid
29	Not valid during coordinated move
30	Sequence segment too short
31	Total move distance in a sequence > 2 billion
32	More than 511 segments in a sequence
41	Contouring record range error
42	Contour data being sent too slowly
46	Gear axis both master and follower
47	Gearing and coordinated moves cannot run simultaneously
50	N ot enough fields
51	Question mark not valid
52	Missing " or string too long
53	Error in {}
54	Question mark part of string
55	Missing [or]
56	Array index invalid or out of range
57	Bad function or array
58	Unrecognized command in a command response (i.e. _GNX)
59	Mis matched parentheses

#	*Description*
60	Download error - line too long or too many lines
61	Duplicate or bad label
62	Too many labels
65	IN command must have a comma
66	A rray space full
67	Too many arrays or variables
71	IN only valid in task #0
80	Record mode already running
81	No array or source specified
82	U ndefined array
83	Not a valid number
84	Too many elements
90	Only X Y Z W valid operand
95	TM too large for stepper pulse
96	SM jumper needs to be installed for stepper motor operation
100	Not valid when running ECAM
101	Improper index into ET (must be 0-256)
102	No master axis defined for ECAM
103	Master axis modulus greater than 256*EP value
104	Not valid when axis performing ECAM
105	EB1 command must be given first
118	Controller has GL1600 not GL1800

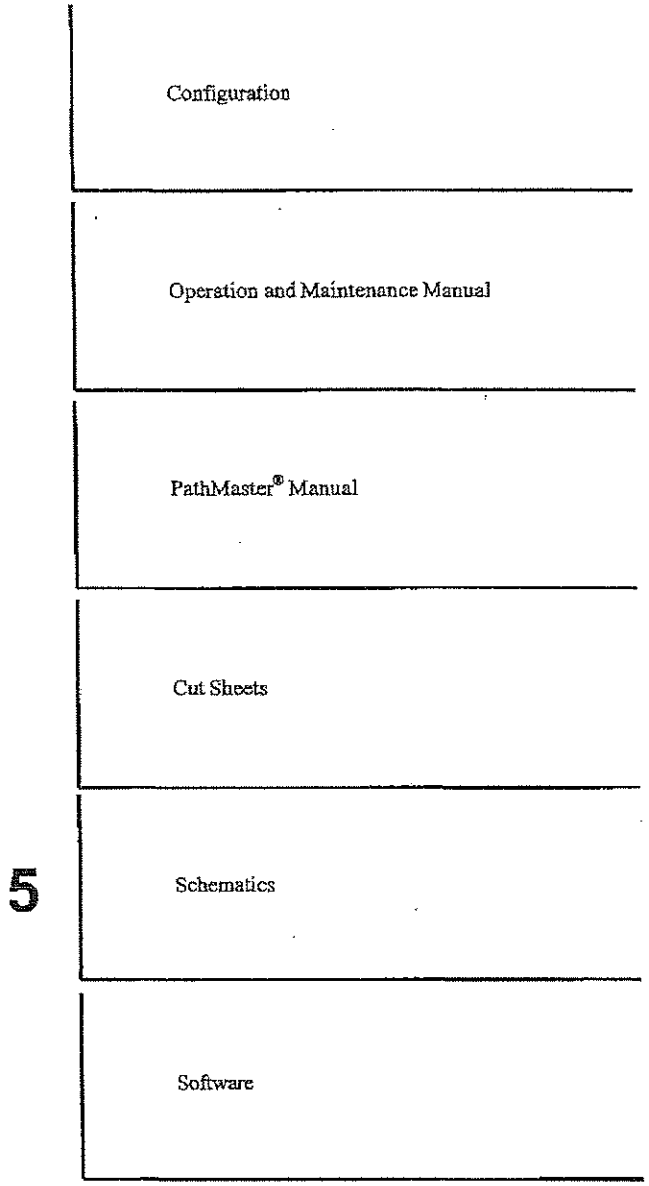
Cut Sheets


Configuration
Operation and Maintenance Manual
PathMaster® Manual
4
Cut Sheets
Schematics
Software

Cut Sheets

Included on this cd are technical data sheets for componants installed on the Workcell. To view these documents click the button below.

Schematics

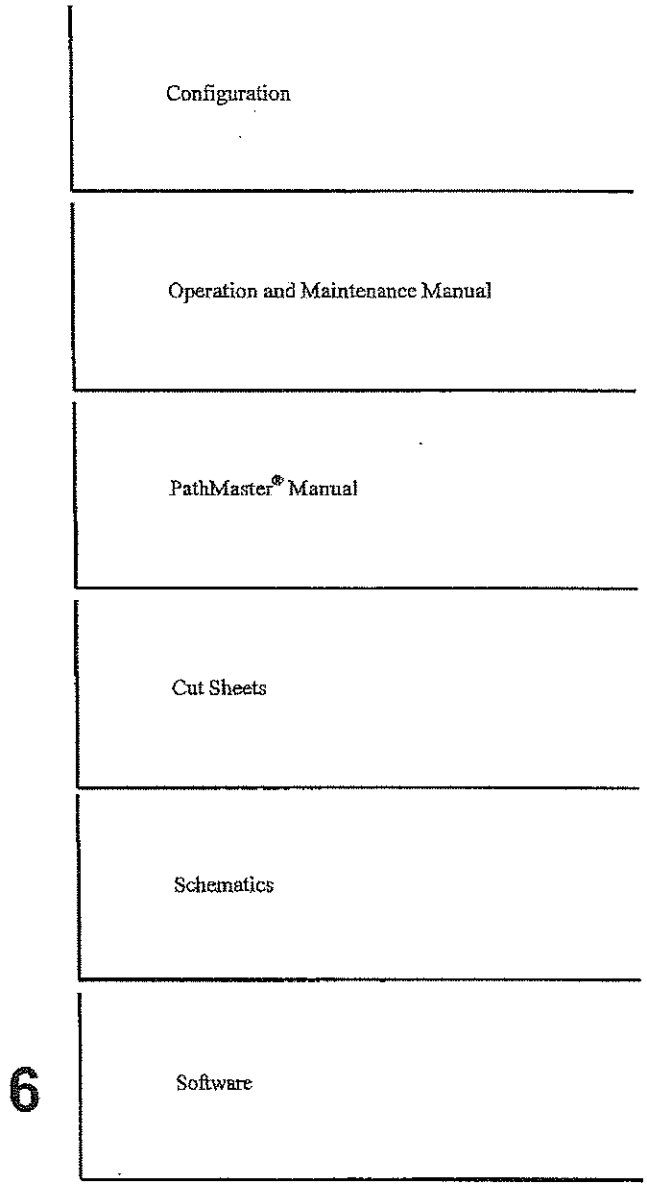

Configuration
Operation and Maintenance Manual
PathMaster® Manual
Cut Sheets
5
Schematics
Software

Schematics

Included on this cd is a set of schematics for this unit. To view these schematics online, click the button below.

NOTE: Before you can view the schematics, you must have an AutoCAD® compatible viewer installed. The AutoCAD® viewer, Volo™ View Express, is provided on this cd.

Software


Configuration
Operation and Maintenance Manual
PathMaster® Manual
Cut Sheets
Schematics
6
Software

Software

CD ROM

- One (1) CD ROM is included with this manual. It contains the PathMaster® software used to program the Dispensing System via A windows interface. To "Install PathMaster®" NOTE: If you have previously installed PathMaster®, be sure to uninstall the old version before installing the new version.
- This CD also includes a few helpful tutorials explaining some of the most often used functions of the PathMaster® software.

Note: Your PathMaster® CD comes equipped with the ability to produce floppy disks. On this CD you will find a directory labeled "144 MB". Simply copy the files from each disk directory to individual floppies for a complete set of installation floppy disks.

Program (s)

- On this CD you will find a directory labeled Software it contains a backup copy of the main program *xxxx_m01.txt,* where *xxxx* is the serial number of the machine and *m01* is the main program revision. The machine was shipped from Precision Valve & Automation, Inc. with the original copy of this main program resident in memory. In certain situations, a PathMaster® project backup file *xxxx_P01.bck* may also be included on the folder, where *xxxx* is the serial number of the machine and *p01* is the project file revision.

To prevent unitentional alteration of the files, the disk has been write-protected.

EXHIBIT 69

Fw PVA Test Demonstration Trials 2

From: restronicsbill@verizon.net
Sent: Friday, March 23, 2012 12:08 PM
To: Jonathan Urquhart
Cc: David Gomez
Subject: Fw: PVA Test Demonstration Trials

See spaceX reply to my email below
Bill Burns, Restronics So Cal, 310-634-7472 Sent from Wireless BlackBerry

-----Original Message-----
From: John Pena <John.Pena@spacex.com>
Date: Fri, 23 Mar 2012 15:59:29
To: <restronicsbill@verizon.net><restronicsbill@verizon.net>
Subject: Re: PVA Test Demonstration Trials

Bill, thanks for the email, I wasn't wholly counting on the automated mixing system but would of liked to have seen both processes. I am ok with a demonstration involving the premixing of the materials to see how involved the process is from start to finish with the purging of the system.

We have some time before making our final selection process and anticipate delivery will be required some time in Q3.

As far as the Arathane materials they are new to us and we have not tried them yet and was hoping to learn from this trip the process to bring back to try out on our 350 machine or learn if any modifications would be required, wouldn't anticipate any but you never know.

As far as the meter mixing of a three part system dispersed at the nozzle I would be interested to hear about what is planned or being proposed and what would be the delta equipment and cost necessary to go from a premixing to a auto mix spray system.

Thanks
John Pena

Sent from my iPad

On Mar 23, 2012, at 8:18 AM,
"restronicsbill@verizon.net<mailto:restronicsbill@verizon.net>"
<restronicsbill@verizon.net<mailto:restronicsbill@verizon.net>> wrote:

Morning John. I just want to clarify what you will not see. We cannot demonstrate a fully automated mixing system for the 3 part process yet nor can we even put together a test while you are there. We can show equipment with mixing capability for 2 part materials but 3 part is such a special application that there is nothing available to run this process yet. We are looking into it but there will be much testing required. As I said, presenting pre-mixed material to the machine, is doable because it will be as if it is a single material.

If SpaceX is putting a lot of weight on the automated mix process, then it will be best to postpone the visit until we have some testing completed. As I mentioned we are planning on testing the 3 part system soon but this will not something we will show potential customers until we get it down.

Right now it is a “science project”, and as I am sure SpaceX understands, we will not launch until we have the confidence of a high probability of success.

I have a few questions; have you guys mixed any of this material yet yourselves? Have you tried to coat boards in any fashion once you have mixed it? And if so what test results did you get?
Bill Burns, Restronics So Cal, 310-634-7472 Sent from Wireless BlackBerry

Fw PVA Test Demonstration Trials

From: restronicsbill@verizon.net
Sent: Thursday, March 22, 2012 8:19 PM
To: Jonathan Urquhart
Cc: David Gomez
Subject: Fw: PVA Test Demonstration Trials

Hi Jon let me know your thoughts and if there is still time to get this done on the 27th. I told
them yesterday we were still a go for that day. Now with these desires not sure. They are very
interested in your efforts to three part mix in line rather than mix a small batch and purge their
life away. They do understand they may have to do it that way but are excited to have a more
automated method
Bill Burns, Restronics So Cal, 310-634-7472 Sent from Wireless BlackBerry

From: John Pena <John.Pena@spacex.com>
Date: Fri, 23 Mar 2012 00:02:31 +0000
To: Bill Burns<restronicsbill@verizon.net>
Subject: PVA Test Demonstration Trials

Bill please forward to PVA our desired test witness plan

Planned Test Demonstration to include witnessing of the following
- Mixing materials to correct ratio and viscosity
- Setting up of the materials and machine
- Programming of machine to apply material with selective coating for keep out areas to mitigate
masking
- Examination of any over spray in keep out areas
- Examination of coated boards and process to NASA 8739.1 standards 10.2 - 10.5
- Verify thickness (.0003 +/- .0001) of coating application with aluminum coupons
- A hardness coupon (aluminum weighing dish with at least 0.25" of material)
- PVA's recommendations on how often to purge the machine and scheduled maintenance
- Purging of the machine valves, nozzles, canisters and lines
Forwarded to PVA were
- PWB unpopulated for set up trials
- PCBA populated for set up trials
- PCBA populated for Test Demonstration
- Arathane 5750 kit

Thanks,

John Pena
Avionics Clean Room Manager
310-363-6992

Fw Arathane 5750 Spec

From: restronicsbill@verizon.net
Sent: Tuesday, March 13, 2012 3:21 PM
To: Jonathan Urquhart
Cc: David Gomez
Subject: Fw: Arathane 5750 Spec
Attachments: 5750-Arathane_5750AB-LV_TDS.pdf

Hello John. I would like to talk to you about this material for conformal coating approved by
NASA to help eliminate out gassing with parts going into space. I think David has spoken to you
about our customer SpaceX. They build full blown rocket ships. They plan on pre-mixing this
material part A part B and a 3rd part, thinner in small batches apply to board and the purge
system because of shelf life once mixed. Sounds screwy to me. They first were looking at the
20th of this month but time is too short now so the 27th is next date to consider for demo. They
will be send this material and boards soon. Do they send to your attention? Call me when you
can. Thanks
Bill Burns, Restronics So Cal, 310-634-7472 Sent from Wireless BlackBerry

From: David Hwang <David.Hwang@spacex.com>
Date: Tue, 13 Mar 2012 18:08:17 +0000
To: restronicsbill@verizon.net<restronicsbill@verizon.net>
Subject: Arathane 5750 Spec

David Hwang
Avionics Materials & Process Engineer| Space Exploration Technologies
1 Rocket Road | Hawthorne, CA 90250 | tel. 310.363.6400 x21267 |
david.hwang@spacex.com

CERTIFICATE OF SERVICE

The undersigned hereby certifies that on August 24, 2018, a true and correct copy of **DECLARATION OF JONATHAN URQUHART IN SUPPORT OF DEFENDANT PRECISION VALVE & AUTOMATION, INC.'S MOTION FOR SUMMARY JUDGMENT** has been served via ECF upon all counsel of record in the Court's electronic filing system.

By: /s/ Jerry Dumlao

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